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NATIONAL FUEL RESEARCH INSTITUTE, DHANBAD

THE National Fuel Research Institute which was opened by President Rajendra Prasad during the fourth week of April, constitutes the third in the chain of the eleven laboratories sponsored by our farsighted National Government. The creation of the Fuel Research Institute is the fulfilment of the persistent demands made from time to time during the last twenty years, by the three Coal Commissions which considered the position of coal industry in India. It was, however, left to Sir S. S. Bhatnagar to galvanise these recommendations into action and establish the Institute.

The Institute will interest itself with major problems pertaining to fuels in its broadest sense ; the solid, liquid and gaseous fuels will come under its perview and in addition, the Institute will organise a physical and chemical survey of Indian coals, whose deposits in India are none too abundant. This circumstance calls for an intelligent conservation of our resources with a full and proper appreciation of the growing demands of our present industries and of our future commitments. Our resources of high grade metallurgical coal are limited and so far as our present estimates go, they are expected to last for not more than 50 years. This is a serious situation which calls forth immediate and careful investigation. Our total annual output of all kinds of coal amounts to about 30 million tons, of which a third is consumed by our railways, a fourth is accounted for by metallurgical industries while a tenth of the output is utilised for domestic purposes. It is estimated that about 13 million tons of high grade coal is being used for purposes for which lower grades would suffice.

Processing coal for the recovery of valuable byproducts which provide the raw material for the fine chemical industry, constitutes an important item in the research programme of

the Institute. Sir J. C. Ghosh, who addressed the distinguished gathering on this occasion, disclosed that India imports 2·8 million tons of petroleum products valued at 40 crores of rupees. "Modern research", Sir J. C. Ghosh said, "has shown that it is possible to produce oil from coals of a poorer type, of which we have unlimited resources. Prudence demands that at least 50 per cent. of our petroleum requirements should be secured by the conversion of indigenous coal into oil." Continuing, Sir J. C. Ghosh added that demands for various types of fuel were not static. Even at snail's pace, increased production could be expected to be about one per cent. compound interest annually. And if, as the result of the labour of the Planning Commission, the Government gave the highest priority to the development of resources, the annual rate of increase might easily be five per cent. compound interest. Hence, research and its utilisation should be planned on the basis of this increased demand. He declared that it would be a mistake to ignore the fact that the environmental climate for applied research in India was not the same as in other countries. He warned the Indian industrialists that mere import of machinery and plant and technical talent from abroad was not all that was necessary for industrialisation of India. In these days of rapid progress, the imported plant and machinery might become obsolete in ten years. More light and better guidance would come as a result of the talented men and women working in these homes of research.

TWO HUNDRED RESEARCH SCHOLARSHIPS INSTITUTED

IN pursuance of the recommendations of the Scientific Manpower Committee, the Ministry of Education, Government of India, have instituted 50 senior and 150 junior research training scholarships in Universities and other educational and research institutions.

Further information about the scheme of research scholarships is given in a statement laid on the table of the House by the Education Minister. The objective of the scheme is to enable deserving and talented students to engage in scientific and industrial research and to acquire, as a result of such training, knowledge and experience for holding research positions.

The scheme provides for two grades of scholarships tenable for a period of three years—senior scholarships of Rs. 200 per month and junior scholarships of Rs. 100 per month.

The Senior scholarships are available for advanced research in basic science and for post-graduate research in engineering and technological subjects. The scholarships are awarded to research workers who have taken at least a Master's Degree in Science or a good Degree for advanced diploma for engineering or technology.

The Junior scholarships are available for research of comparatively lower standards at post-graduate level, and are awarded generally to those who have taken at least a good Honours Degree in Science or a Degree in Technology.

In the terms and conditions governing the award of the scholarships, it is laid down that the heads of the institutions concerned shall make the award strictly on the basis of merit, subject to the approval of the Government of India. The grants on account of the scholarships will be given to the institutions concerned in quarterly instalments in advance, and the heads of the institutions will disburse the amount to the scholars at the end of every month. It is also laid down that the heads of the institutions will submit quarterly reports on the satisfactory progress of the work of the scholars to the Government of India. The continuance of the scholarships will depend upon the scholars making satisfactory progress with their work.

URANIUM MINERALS OF INDIA*

N. R. SRINIVASAN

(Department of Metallurgy, Indian Institute of Science, Bangalore 3)

URANIUM is known to occur in about twenty minerals in India, some of which may contain it as the chief constituent while in others only a trace is present. It is desirable, therefore, to have knowledge of all the common uranium minerals whether of immediate commercial significance or not, because where one such mineral is found others are likely to occur nearby.

It is customary for geologists to classify these minerals as primary and secondary. Primary minerals are those that have not been changed since they were originally deposited, whereas secondary minerals are formed from the former by weathering or natural processes. The secondary ones may be different in appearance and may occur far removed from their origin. The primary minerals are usually found in vein deposits of pegmatites. They are dark brown or black, heavy and lustrous. The most important mineral of this class is pitchblende, essentially uranium oxide, which is the source of major uranium production in the Belgian Congo, Canada and Czechoslovakia. It is frequently found in association with sulphide ores of silver, cobalt, nickel and copper. Uraninite is another which has most of the characteristics of pitchblende but does not occur in considerable quantities except in association with pitchblende. Then, there are the uranium bearing oxides of tantalum, niobium and titanium, such as betafite, euxenite and samarskite which contain small percentages of uranium and have been worked to a limited extent in some parts of the world.

The secondary uranium minerals are characterised by bright yellow, orange and green colours and are usually present as powdery masses or groups of small crystals. They may occur in almost any type of rock either alone or with primary minerals, and have lower percentages of uranium. Carnotite is one such and has become commercially important in some foreign countries as a source of vanadium and radium. It may be bright yellow brown, grey or pale green depending upon local conditions. Autunite is bright lemon to yellow and invariably fluoresces under ultraviolet light. There are others such as torbernite but these are rare.

Occurrence

The occurrence of uranium minerals in some parts of India has been known as early as 1901.[1] The Geological Survey of India have done the early work in locating uranium deposits although no serious attempt had been made to ascertain the amount of uranium available in this country. The earlier chemical data cannot be relied upon as it has been specifically stated that "the analyses have no claim to great accuracy". During the past five years or so, many investigations have been conducted on the composition and age of uranium minerals, and the results have been reported in Indian Journals. However, there is no compilation which gives ready reference to all the existing sources of uranium in India, and in the following a thorough survey is made of the recorded occurrences of uranium minerals in India.

(1) Pitchblende[2,3] occurs in a pegmatite which crops out on a hill known as Akbhari Pahar in Gaya District, Bihar, rising 200 feet above the alluvium. The indications on the surface consisted of light yellow uranium ochre and as the pits were deepened, contained nodules of pure pitchblende. It occurs in Pichehli, Gaya District, in the felspar of the pegmatite and assayed to 66.34% of U_3O_8. It is also known to exist in Dhalbhum District. Prospecting in Bihar did not reveal a very large deposit.

(2) Uraninite[5] with other uranium minerals has been found in two localities in Singar Zamindari, Gaya District.

(3) Samarskite is known to occur in the Sankara mine, Nellore District, Madras, embedded wholly or partly in felspar, with small books of mica attached to it. It occurs in varying masses from minute crystals to several pounds in weight, although there were no indications of a continuous vein. In addition, Allanite[7] and two uranium-bearing minerals were also found in the locality. The mineral is also known to occur in Yedur, Bangalore District.[8]

(4) A tantaloniobate[9] of uranyl, iron and rare earths was found 5 miles to the west of

* The Government of India have recently announced rewards for the discovery in India of deposits of uranium ore. The new deposits would have to be no less than 100 miles from those already known to the Indian Atomic Energy Commission. An award of upto Rs. 10,000 may be given if in the Government's opinion the new deposit is capable of producing 100 tons of uranium oxide in ore.

Vaiyampatti, Trichy District. The mineral was probably hatchettolite or endeiolite.

(5) A titanoniobate[3] of uranyl and rare earths, probably closely allied to euxenite, was found in Erania Taluq, Travancore.

(6) Uranium Ochre[3], usually encrusting pitchblende in Gaya District, has been noticed as rounded nodules in the felspar.

(7) Autunite[3] occurring as lemon yellow incrustations on some of the minerals, in Gaya District, was found to be less common and not crystalline.

(8) Torbernite[3] of bright green colour was found more in the same locality as encrusting mica, apatite and other minerals of the pegmatite and along cleavages in felspar.

(9) Sipylite[3] of red brown resinous lustre was detected with samarskite in Sankara mine and also was obtained from Ruzulapad mica mine.

(10) Gummite[10] has been discovered in Ajmer-Merwara, surrounding pitchblende, as red shells.

(11) Uranosphærite[11] has been found on the south side of Rewat Hill, Jodhpur.

(12) Uranophane[10] is recently reported to occur in Ajmer.

(13) Thorianite[9] was found as a perfect crystal in Travancore, and contained a high percentage of uranium oxide.

(14) Tantalite-niobite[12] found near Vaiyampatti when analysed contained uranium. In addition, traces of uranium are always found in monazite which might also be extracted by suitable methods.

Though these are the occurrences reported in literature, the Director, Geological Survey of India, observed as early as 1914 that "there seems to be no reason why uranium minerals should not be found at depths". With the impetus given in recent years by the atomic energy program, newer technique and instruments for prospecting have been evolved. These are described admirably in many governmental publications,[13-15] reference to which may also be made by Indian prospectors.

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1. *Memoirs, G. S. I* 1901, **34**, 31. 2. *Records, G.S.I.*, 1914 **44**, 24. 3. *Ibid.*, 1919, **50**, 255. 4. *Ibid.*, 1921, **53**, 297. 5. *Ibid.*, 1921, **52**, 308. 6. *Ibid.*, 1911, **41**, 210. 7. *Ibid.*, 1920, **51**, 210. 8. *Ibid.*, 1930, **64**, 424, 9. *Ibid.*, 1917, **48**, 8. 10. *Jour. Sci. Ind. Res.*, 1948, **7**. 35. 11. *Records, G. S. I.*, 1922, **54**, 36. 12. *Ibid.*, 1918, **48**, 8. 13. 'Prospecting for Uranium," by the United States Atomic Energy Commission and the United States Geological Survey, 1949. 14. "Guide to Prospectors," by His Majesty's Stationery Office, London, 1949. 15. "Radioactive Mineral Deposits," by Bureau of Mineral Resources, Geology and Geophysics, Australia, 1948.

SYMPOSIUM ON THE HISTORY OF SCIENCE IN S. ASIA

THE Council of the National Institute of Sciences of India, in collaboration with the UNESCO South Asia Science Co-operation Office, propose to hold this winter in Delhi a Symposium on the History of Science in South Asia. It is expected that Dr. J. Needham, F.R.S., who is at present engaged in the writing of a History of Science in China, may come to India to participate in the Symposium.

It is proposed to constitute a study group for the Symposium with 15 scholars from within India and the adjacent countries, which will hold consecutive sessions for 3-4 days, where each scholar will present a paper on a specified subject, which will be discussed with particular reference to the impact of scientific knowledge on the problems of social organisation and human civilisation in general.

The following tentative agenda has been drawn up in order to give an idea of the scope of the Symposium which will cover the period up to the end of the 18th century.

1. (*a*) Chronology of the achievements; (*b*) Defining the periods of achievements; 2. Life stories of the pioneers; 3. Contacts with outside on countries' own initiative or by the adventurous trips of foreigners; 4. General history of those periods with stress on social conditions; 5. Impact of the discoveries of the scientists on military strategy of the kings and on the general living conditions like town planning, public health, agriculture, transport and industries.

Both historians and scientists are welcome to take part in the Symposium as it is expected that they will supplement each other's work and study.

THE CUDDAPAH IGNEOUS ACTIVITY

V. S. DUBEY

(Benares Hindu University)

THE author read a paper at the Indian Science Congress at Patna, in 1948, in which the view was expressed that the trap occurring in Delhi Series near Bayana was the same as the Gwalior trap; and the Erinpura granite, being post-Delhi, was of the same age as the other acid rocks of late Bijawar period of Sone Valley, and these were intruded at the end of the Cuddapah period. Recently an interesting paper has been published by Prof. A. Holmes in the Geological Magazine, Sept.-Oct. 1949, in which the age of uranite occurring in the post-Delhi pegmatites of Rajputana, which are associated with Erinpura granite, has been determined by radioactive method. The age determined amounts to 735 million years and this now definitely confirms the view expressed by the writer[1] that the Erinpura granites were intruded at the end of the Cuddapah period. For the last three years the writer, with the help of his research students, has been carrying on field studies on the geology of the Bijawars of Sone Valley and of Bundelkhand. This has considerably clarified the views on the igneous cycle of the Cuddapah age.

The conclusions arrived at as a result of this study are that the Cuddapahs can be divided into three parts: Lower, Middle and Upper. The Lower period was without any kind of igneous activity. In the Middle period there was vast igneous activity as a result of which several thousand feet of basic lavas were poured out in Central and Southern India. The basalts of this age are found wherever the Cuddapahs or their equivalents are exposed. After this, came the intrusion of the ultrabasic rocks, which are the source* of diamonds. After this, at the end of Upper Cuddapah period came very thick flows of acid tuffs and rhyolites, and intrusions of granophyres, felsites, and granites. In Sone Valley, besides the extensive development of acid tuffs, there are big intrusions of granophyres and flows of rhyolites. In Bundelkhand also the acid tuffs have been found. According to the writer, these acid flows and intrusions of the Sone Valley and Bundelkhand are contemporaneous with the Erinpura granites of Rajputana. In Bundelkhand and Sone Valley what has been called as Lower Vindhyan such as Semri Series really belongs to the Upper Cuddapahs, and in Rajputana also, some of the formations referred to as Lower Vindhyan correspond to the Upper Cuddapahs and the Malani rhyolites and the rhyolites of Sone Valley and Bundelkhand are of the same age. The granites of Jalor and Siwana are almost of the same age as these other acid rocks. All these acid flows and intrusions mark the end of the Upper Cuddapah igneous activity accompanied by heavy folding. Thus the igneous cycle is clear and complete.

The age of the acid intrusions of post-Delhi period corresponding to Erinpura granite has been estimated to be about 735 million years by Prof. Holmes. The basalts are slightly older and in Sone Valley a few thousand feet of quartzites intervene between the basaltic flows and acid tuffs. So the age of these Bijawar basalts may be somewhere about 800 million years. The Radium-helium method used by the writer[2] gave the age of 500 million years for these Gwalior basalts. From the exact determination made by the uranium lead method now it appears that about 30 – 40% of helium might have escaped from these basalts. As regards the age of the beginning of the Cuddapahs, it will be somewhere between 800 and 900 million years. This corresponds to a lead ratio of about 0·11 which has been taken by Prof. Holmes as the lower limit of the Upper pre-Cambrian in the different parts of the world. Thus in India, in the Sone Valley, in the Semeri Series of Bundelkhand, and in Rajputana, the age of these granites and acid flows marking the end of the Cuddapahs can now be fixed as the end of the Upper pre-Cambrian. The writer is of the opinion that there may be several areas in Norhtern India where the granites and other acid rocks of this age occur but which have not been differentiated from the other older granites like Bundelkhand. In Bundelkhand the acid tuff flows are definitely

* Near Panna, a diamondiferous kimberlite plug has been located. In the Sone Valley a large amount of ultrabasic rocks of this age intruding the basalts have been studied by the writer. It is highly probable that these ultrabasic rocks also occur in Hyderabad State and Sambalpur area in Orissa where they have been the source of diamonds occurring in these areas. But they still remain to be located and will be of great economic importance.

much later than the Bundelkhand granite, and in Sone Valley these granophyres are of slightly later age than the basic Gwalior lavas, being much later than the Bundelkhand granite.

The detailed study of the Bijawars of Sone Valley and of Bundelkhand and of other areas in Northen India will shortly be published in detail.

1. Dubey, V. S., and Pathak, B. D., *Proc. Ind. Sci. Congress*, Patna, 1948. 2. Holmes, The age of the earth *(Bullet. Nat. Res. Council U.S.A.)*, 1931, p. 415.

WHO ON THE USE OF STREPTOMYCIN

THE Standing Technical Committee of the Tuberculosis Association of India have resolved that the following recommendations of the Expert Committee of the World Health Organization on the use of Streptomycin be adopted in India :—

Streptomycin, while being useful in the treatment of several forms of tuberculosis, is, at its best, only a part of the general treatment in most forms of the disease and is partially dependent for its full effect upon other more common therapeutic measures, such as bed rest, pneumothorax or chest surgery. It is generally known that even under the best therapeutic conditions, severe toxic manifestations occur, some of them fairly frequently. Furthermore, tubercle bacilli in certain patients acquire resistance to streptomycin which eventually necessitates termination of specific therapy. It was, therefore, recommended that during the initial period of study and use streptomycin should be distributed by governments only to institutions and medical centres regularly concerned with the diagnosis and treatment of tuberculosis. With such safeguards, limited supplies will be beneficially employed under the supervision of physicians experienced in streptomycin therapy, aware of its dangers and contra-indications and prepared to carry on further research on the more precise use of this and other newly developed antibiotics against tuberculosis.

Type of Cases Suitable for Treatment.—Streptomycin was not found to be suitable for all types and stages of tuberculosis infections.

It was unanimously agreed that patients with tuberculous meningitis and generalized hematogenous or miliary tuberculosis should be given prior consideration, because of the extremely high mortality-rate among untreated cases and the lack of any other dependable therapeutic approach.

It appeared that fulminating types of bronchopneumonic pulmonary tuberculosis of recent origin, which have not progressed beyond the possibility of healing, may frequently be ameliorated by streptomycin; residual lesions of a more chronic and destructive character may require other forms of treatment.

Some of the most distressing complications of pulmonary tuberculosis, especially tuberculous laryngitis and tuberculous enteritis, may be greatly benefited symptomatically by appropriate streptomycin treatment.

Finally, streptomycin was found to be particularly effective in the treatment of tuberculous sinuses and fistulæ; less favourable results have so far been reported in renal tuberculosis and in tuberculosis of bones, joints and glands.

Regimens of Treatment.—Optimum streptomycin regimens for the different forms of tuberculosis have not been determined with sufficient precision to make exact recommendations possible at this time. At the present stage of knowledge, the medical practitioner cannot expect to be provided with a universally accepted formula, but will have to make his own choice from several regimens recommended by various research workers. The group of experts could therefore hardly do more than define certain general principles to be observed in the application of streptomycin therapy. Thus, it was suggested, among other things, that in certain cases when the disease changes for the worse or when a relapse occurs, a subsequent or second course of streptomycin may be indicated, provided that the tubercle bacilli have not become predominantly streptomycin-resistant. The indications for a second course of treatment cannot, in the present state of knowledge, be specified precisely, but must be determined after careful review of all clinical and laboratory data in each case. There was, in the opinion of the group, some evidence that combined therapy (streptomycin *plus* sulphone derivatives or para-aminosalicylic acid) may be more effective in some forms of tuberculosis than either drugs used alone. At the present time, combined therapy shows greatest promise in the treatment of miliary tuberculosis and tuberculous meningitis.

ROOM ACOUSTICS AND ULTRASONICS

DR. R. N. GHOSH, in his Presidential Address to the Physics Section of the 37th Indian Science Congress, held at Poona, referred to the important contributions made by Prof. Sir C. V. Raman to the field of sonics and ultrasonics. In this connection, he made particular mention of the theory of vibrations of bowed strings, impact of pianoforte hammer, the harmonic contents of tabala and the discovery of the laws of diffraction of ultrasonic waves. Further, he briefly discussed the mechanism of ultrasonic absorption by liquids and stressed the fact that in the liquid state the major portion of the absorption of ultrasonic energy, which is quantised, is due to its semi-crystalline structure.

The major portion of the address was devoted to Room Acoustics. Starting from the fundamental experimental investigations of Sabine, Dr. Ghosh traced several inadequacies of the geometrical theories. The wave approach, which takes into account the phenomenon of room resonances, was briefly outlined. He derived the expressions for the characteristic frequencies of rectangular room and wave damping coefficient and showed that the decay rate would be different for different modes of vibration, *viz.*, axial, tangential and oblique. He then discussed the case of a rectangular room with uniform distribution of absorbing material, driven at a known frequency by a source situated at a corner of the room and arrived at the expression for the average pressure at a point and compared it with Sabine's statistical result. He pointed out the difference, which consists in the value of absorption coefficient used. He added that the problem of non-uniform distribution of absorbing material in a rectangular room could be solved by (1) the method of successive approximations, (2) Fourier expansions, and (3) the application of Dirac's δ-function. In this connection he brought out the fact that a piece of absorbing material produces most effective absorption when located at a place where most of the wave functions have their maxima, which in the case of a rectangular room happens to be the corners and edges. Next he mentioned about the work of Morse and Bolt in connection with the application of Dirac's δ-function to the problem of ergodic motion and the Index of Randomness. The accurate methods of the measurement of Acoustic impedance were then described.

Finally, before concluding the address, Dr. Ghosh drew attention to the important aspect of design and manufacture of Acoustical Apparatus in India and mentioned about the lead given by Bhatt and his associates in this direction.

REWARDS FOR DISCOVERY OF URANIUM AND BERYL ORES

REWARDS for the discovery in India of deposits of Uranium ore and Beryl ore are to be granted by the Government of India. In the case of Uranium, the new deposits would have to be not less than 100 miles, and in the case of Beryl, 50 miles from any other deposits of these ores the existence of which is already known to the Indian Atomic Energy Commission. Government reserves the right to determine whether a particular discovery is the first from a particular location.

An award of up to Rs. 10,000 may be given if, in Government's opinion, a new deposit is capable of producing 100 tons of Uranium oxide in ore, assaying not less than 0·4% U_3O_8. A similar discovery capable of producing 100 tons of Beryl assaying not less than 12% BeO, or other Beryllium mineral in proportionate amount, may earn an award of up to Rs. 2,000.

Should new deposits of both ores, though not sufficient to be of economic importance in themselves, justify prospecting in the nieghbourhood for further deposits, Government may grant funds for this purpose. Grants-in aid for mine development are available to applicants who produce and deliver not less than 20 tons of Uranium ore and 50 tons of Beryl ore from a concession or mining lease not previously worked for these ores.

In order to help prospectors, the Atomic Energy Commission will make without charge tests of samples submitted; and where necessary, further chemical and field tests for determination of ores.

Applications for rewards should be addressed to the Secretary, Atomic Energy Commission, Central Secretariat, North Block, New Delhi. Further details are available in the *Gazette of India* of April 15, 1950.

Officers or other employees of the Government of India, including employees of the Atomic Energy Commission, shall not be eligible for these rewards.

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ON THE SCATTERING OF FAST ELECTRONS

THE scattering formula for fast electrons using Dirac's relativistic equations has been deduced by Mott (1929)[1]. His calculations become difficult owing to the necessity of solving Dirac's equations for the electron in a Coulomb field. The solutions in this case are in the form of infinite series. The scattered function obtained from the asymptotic expansion of these solutions cannot be summed. Hence an approximate formula for the scattered intensity is obtained in a round about way. By regarding the electrostatic interaction as small, the first approximation of the scattered intensity (Born's approximation) can, however, be obtained in a much simpler way.

A beam of fast electrons is incident on a nucleus. The differential cross-section for scattering is given by (*vide* Heitler[2])

$$d\phi = \frac{2\pi}{\hbar v} \mid H' \mid^2 p_E \qquad (1)$$

where v is the velocity of the incident electron, $p_E\,dE$ is the number of final states of the system within an energy interval E and E + dE. The matrix element

$$H' = \int \psi_a^* \, V \psi_b \, d\tau \qquad (2)$$

where $V = -\frac{ze^2}{r}$. Following Born's approximation we shall substitute plane waves for ψ_a and ψ_b, the wave functions for the incident and scattered electron. This procedure is valid if the energy of the incident particles is much greater than the ionisation energy. This condition may be written in the form

$$\frac{ze^2}{\hbar v} \ll 1$$

which evidently is always satisfied for the velocity of the incident particle in the relativistic region except for the heaviest elements (even then $\frac{ze^2}{\hbar v} < 1$).

Using relativistic wave-functions for free electron we have,

$$\psi_a = u_a(s) e^{\frac{i}{\hbar c}(\vec{p_a}\,\vec{r})}, \quad \psi_b = u_b(s) e^{\frac{i}{\hbar c}(\vec{p_b}\,\vec{r})} \qquad (3)$$

where p_a and p_b are expressed in energy units, *i.e.*, c multiplied by momentum and u (s)'s are

the well-known Dirac amplitudes. Since the integration in (2) includes summation over the spin variables, we get

$$H' = \frac{Ze^2 \cdot 4\pi\hbar^2c^2}{|\vec{p}_a - \vec{p}_b|^2} u_a^* u_b \qquad (4)$$

In this case, (m being the total mass of the electron),

$$\rho_E = \frac{m^2 v d\Omega}{(2\pi\hbar)^3}$$

and $|\vec{p}_a - \vec{p}_b|^2 = 4p^2 \sin^2 \frac{\theta}{2}$

Thus we have from (1) and (4)

$$d\phi = \left(\frac{Ze^2}{2m_0v^2}\right)^2 \left(1 - \frac{v^2}{c^2}\right) \operatorname{cosec}^4 \frac{\theta}{2} |u_a^* u_b|^2 d\Omega (5)$$

Now for a particular spin direction in the initial state, we have two different possible spin directions in the final state. These transitions we represent by $\uparrow\uparrow$ and $\uparrow\downarrow$. Corresponding to the opposite spin direction in the initial state there are again two possible transitions which we represent by $\downarrow\uparrow, \downarrow\downarrow$. The values of $u_a^* u_b$ for these four cases can be easily calculated from the well-known values of u (s)'s (*vide* Heitler[2], p. 86). In this case for the initial electron $p_x = p_y = o$ and $p_z = p$ and for the final electron $p_y = o$, $p_z = p \sin\theta$, and $p_z = p\cos\theta$. With these we at once get,

$$\left.\begin{aligned} u_a^* u_b &= \left(1 + \frac{p^2\cos\theta}{(\mu+E)^2}\right)\left(1 + \frac{p^2}{(\mu+E)^2}\right)^{-1} \\ &\qquad \text{for } \uparrow\uparrow \text{ transition} \\ &= \frac{p^2 \sin\theta}{(\mu+E)^2}\left(1 + \frac{p^2}{(\mu+E)^2}\right)^{-1} \\ &\qquad \text{for } \uparrow\downarrow \text{ transition} \end{aligned}\right\} (6)$$

For $\downarrow\downarrow$ and $\downarrow\uparrow$ transitions $u_a^* u_b$ is same as in $\uparrow\uparrow$ and $\uparrow\downarrow$ transitions respectively. To get the total cross section for scattering we shall have to sum (5) over both spin directions in the final state. Thus squaring and adding we get from (6)

$$\Sigma |u_a^* u_b|^2 = \left(1 - \frac{v^2}{c^2}\sin^2\frac{\theta}{2}\right) \qquad (7)$$

Averaging over the initial spin directions keeps (7) unaltered. Thus we get for the total differential cross section

$$d\phi = \left(\frac{Ze^2}{2m_0v^2}\right)^2 \left(1 - \frac{v^2}{c^2}\right) \operatorname{cosec}^4 \frac{\theta}{2} \left(1 - \frac{v^2}{c^2}\sin^2\frac{\theta}{2}\right) d\Omega \quad (8)$$

This agrees with the first approximation of Mott's formula.

Mott has however pushed his calculations a stage further and obtained a higher approximation term as well.

In the method used here we can proceed to higher approximation only by using the idea of intermediate states, which will be difficult. Hence the higher approximation terms cannot be obtained.

We wish to express our grateful thanks to Prof. K. C. Kar, D.Sc., for his kind interest and encouragement.

Physical Laboratory, S. Sen Gupta.
Presidency College, P. P. Chattarji.
Calcutta,
February 21, 1950.

1. Mott, *Proc. Roy. Soc.*, 1929, A. **124**, 425. 2. Heitler, *Quantum theory of radiation*, 1949.

UNSTABLE PENDANT DROPS IN RELATION TO DROP-WEIGHT METHOD OF SURFACE TENSION

Working from the original Harkins and Brown drop-weight method of surface tension determination, Brown and McCormick[1] have shown, by dimensional analysis, that when drops are similar in shape at the unstable stage, equal fractions of the whole drop become detached, and that if the usual flat tip of a definite radius (as in Harkins and Brown method) is replaced by an inverted cone all unstable drops hanging from such a cone are similar in shape.

On the above considerations a practical conical tip method has been developed by them for determination of surface tension of a liquid by comparison with a standard liquid of known surface tension, in which no correction factors inherent in Harkins and Brown method are involved. The equation worked out theoretically by Brown and McCormick for their new method is

$$\frac{\gamma_1}{\gamma_2} = \left(\frac{m_1}{m_2}\right)^{2/3} \left(\frac{\rho_1}{\rho_2}\right)^{1/2} \qquad (1)$$

where γ, m, and ρ are surface tension, mass of single drop, and density respectively of the liquid and the subscripts 1 and 2 refer to the two different liquids with similar drops for comparison, one being of known γ; the quantities m and ρ being measurable for both the liquids.

It is shown possible here to obtain the above relation of Brown and McCormick independently from altogether different considerations given by one of the authors (K.G.P.) in a recent note[2] in which he has derived an equation

$$\frac{\gamma_1}{\gamma_2} = \frac{\sigma_1}{\sigma_2} \cdot \frac{de_1^2}{de_2^2} \qquad (2)$$

for pendant drops in an unstable stage for two liquids 1 and 2, the quantities γ and σ repre-

senting surface tension and density of the liquids respectively, and de, the equatorial diameter of their drops under similar conditions. This equation is assumed to involve the stage of instability postulated by Brown and McCormick.

Now for similar drops of two liquids 1 and 2 having the radii of curvatures b_1 and b_2 at the apex, and the volumes V_1 and V_2, the ratio of the equatorial diameters de_1 and de_2 respectively is given by

$$\frac{de_1}{de_2} = \frac{b_1}{b_2} = \frac{V_1^{1/3}}{V_2^{1/3}} \tag{3}$$

$$\text{or} \frac{de_1^2}{de_2^2} = \frac{V_1^{2/3}}{V_2^{2/3}} \tag{4}$$

Using the above relation, equation (2) becomes

$$\frac{\gamma_1}{\gamma_2} = \frac{\sigma_1}{\sigma_2} \cdot \frac{V_1^{2/3}}{V_2^{2/3}} \tag{5}$$

If with the above exact relation, the assumption of Brown and McCormick that the volumes V′ of the detached portions of the drops at the stage of instability being the constant fractions of their volumes V in unstable stage, is taken to be valid, the equation (5) above becomes

$$\frac{\gamma_1}{\gamma_2} = \frac{\sigma_1}{\sigma_2} \cdot \frac{V_1'^{2/3}}{V_2'^{2/3}}. \tag{6}$$

Introducing the mass quantities, we get

$$\frac{\gamma_1}{\gamma_2} = \frac{\sigma_1}{\sigma_2} \cdot \frac{\left(\frac{m_1}{\sigma_1}\right)^{2/3}}{\left(\frac{m_2}{\sigma_2}\right)^{2/3}} = \left(\frac{m_1}{m_2}\right)^{2/3} \left(\frac{\sigma_1}{\sigma_2}\right)^{1/3} \tag{7}$$

which is the same result as equation (1) above of Brown and McCormick for conical tip. It would be interesting to test how far the unstable pendant drops obey the above relation. This point is under investigation in these laboratories.

Physics Laboratory, N. R. Tawde.
The Institute of Science, K. G. Parvatikar.
Bombay,
April 9, 1950.

1. Brown, R. C., and McCormick, H., *Phil. Mag.*, 1948, **39**, 420. 2. Parvatikar, K. G., *Curr. Sci.*, 1949, **18**, 288.

A NEW ULTRASONIC METHOD FOR DETERMINING ELASTIC CONSTANTS

It is very well known that the breadth of resonance for a piezoelectric plate excited at one of its natural frequencies, is wide enough to allow the excitation of the crystal with sufficient power throughout a considerable frequency range. The author employs this broad frequency region of vibrations in the neighbourhood of one of its natural frequencies as the continuous source for finding transmission maxima through a crystal whose elastic constants are to be determined.

An X-cut quartz plate of thickness 2 mm., silvered on both sides, is made to excite vibrations in a thick plate of a crystal whose fundamental must be of the order of 0·1 to 0·3 Mc/sec. and the ultrasonic wave transmitted by the crystal is communicated into a liquid contained in a glass trough. The diffraction pattern of the ultrasonic grating set up in this liquid is seen with the usual arrangement. When the frequency of the oscillator is varied continuously in the region of one of the natural frequencies of the piezoelectric plate, it is found that the diffraction pattern due to the ultrasonic wave transmitted by the crystal exhibits a series of sharp maxima which are close to each other. Each of these transmission maxima corresponds to the excitation of one of the harmonics of the longitudinal vibrations of the crystal block and the differences between the successive maxima are found to be identical, corresponding very nearly to the longitudinal fundamental of the crystal plate. Such transmission maxima are observed in the neighbourhood of all the natural frequencies of the piezoelectric plate. More number of hese transmission maxima are observed in the lower frequency region and with higher powers of the oscillator. Using the longitudinal fundamental frequency of the crystal thus determined and the thickness of the crystal, the longitudinal velocity and hence the effective elastic constant in the particular direction is calculated with the help of the familiar formulæ. With this type of set-up it is found that the shear modes do not come up prominently. This is also one of the difficulties sometimes encountered in the wedge method developod by Bhagavantam and Bhimasenachar.[1] To overcome this difficulty the author employed a Y-cut quartz plate for determining velocities of shear modes. In place of the X-cut quartz plate, a Y-cut quartz plate is cemented to the crystal and the transmission maxima studied as in the previous case. It is now found that the shear modes are excited more prominently than the longitudinal ones. From transmission maxima thus observed, the shear modes are easily sorted out and the corresponding fundamental frequency determined taking note of their high intensity. The velocity and the

elastic constant for shear wave, in the particular direction, is then calculated in the usual manner.

Using this method the author has determined the elastic constants of potash alum employing crystals of thickness about 1 cm. The values for the elastic constants thus obtained are given in the following table along with those reported earlier.

	C_{11}	C_{12}	C_{44}
Author ..	2·56	1·07	0·85
Voigt[2] ..	2·43	1·009	0·843
R. V. G. Sundara Rao[3] ..	2·56	1·07	0·86
Bhagavantam and B. R. Rao[4]	2·54	1·07	0·84

This method has the main advantage that employing a Y-cut plate shear modes are excited in any crystal with ease. Further, higher accuracy in determination of elastic constants is attained in this method because of the large thickness of the crystal used and the increased number of transmission maxima obtained with moderate powers of the oscillator. On the other hand, the method has the drawback that it requires a crystal block of thickness of the order of 1 to 1·5 cm. and is not suitable for crystals available only in very small sizes. It is also found that there is a definite size effect on the vibrations of the crystals which is being investigated in detail.

The author wishes to express his grateful thanks to Professor C. Mahadevan for giving facilities in his Laboratory.

B. Ramachandra Rao.

Geophysical Laboratory,
Geology Department,
Andhra University,
Waltair,
March 24, 1950.

1. Bhagavantam, S., and Bhimasenachar, J., *Proc. Ind. Acad. Sci.*, 1944, **20**, 298. 2. Voigt, W., *Gott. Nach.*, 1918, **1**, 85. 3. Sundara Rao, R. V. G., *Curr. Sci.*, 1947, **16**, 91. 4. Bhagavantam, S., and Rao, B. R., *Nature*, 1948, **162**, 818.

CHROMATOGRAPHIC SEPARATION OF DYES

Ruggli and Jensen have separated mixtures of direct, basic and acid dyes from an aqueous solution using alumina as adsorbent and have traced certain relationships between the constitution of azo dyes and their adsorbability.[1] Cellulose in the form of filter-paper is of exceptional interest in chromatography and has been extensively studied in recent years, although there has been little application to dyes. One advantage of this method is that the chromatogram is well adapted to visual examination and can be filed after drying for future reference.[2] The technique of paper chromatography for dyestuffs is essentially a refinement of Schönbein's "capillary analysis".[3] A convenient procedure is to dip a rectangular filter-paper with a short stem in the middle in the dyestuff solution (a few c.c. in a glass dish); after a few minutes the dyestuff solution is replaced by a solvent. Draughts are avoided by having the set-up inside a balance case provided with some arrangement (such as double lengths of thin wire or string) for supporting a series of paper strips. The method is useful for acid dyes which separate into sharp and definite bands; *e.g.*, a mixture of the four acid dyes, Naphthol Green B, Tartrazine NS, Solway Blue BS and Orange II can be separated, water being used for adsorption and development.

Basic and direct dyes do not separate into sharp bands from an aqueous or dilute acetic acid solution; but clear separations can be effected when a 1:4 mixture of water and methyl cellosolve acetate is used for adsorption and development. Thus the following mixtures have been separated: (*a*) Methylene Blue, Safranine and Auramine O; (*b*) Chrysophenine CH, Congo Red, and Chlorazol Sky Blue FFS. Auramine O is more strongly adsorbed than Brilliant Green in contrast to their behaviour on alumina.[1] Ruggli and Jensen were unable to separate a mixture of Auramine O and Malachite Green; these have now been separated on paper using pyridine as solvent for adsorption and development, and subsequently exposing the paper to hydrochloric acid vapours. Chromatography of an ether or dioxane solution of the mixture after basification also separates Auramine O from Malachite Green.

A good separation of direct dyes can be obtained on cellulose acetate, nylon or vinyon fabric after suitable activation, *e.g.*, by treatment with *n*-butanol.[4] When two drops of an aqueous solution of the mixture are placed in the centre of the fabric, held taut in an embroidery ring, and a few drops of water are used for development, a clear separation of a mixture of Chrysophenine CH, Congo Red and Durazol Fast Blue 8GS is obtained.

The adsorption of azo dyes on paper generally runs parallel to the number of azo groups

present; the more the number of azo groups, the stronger the adsorption.[1] However, the affinity of the dye for cellulose and other factors plays an important part. Thus a substantive monoazo dye (Direct Fast Yellow FF; a dehydrothiotoluidine derivative) is more strongly adsorbed than a non-substantive disazo dye (Cloth Fast Black B, an acid dye). Disazo dyes of the type ($A_1 \rightarrow Z \leftarrow A_2$) in which at least one of the two diazonium components, A_1 or A_2, contains a nitro group are weakly adsorbed; thus Naphthol Blue Black B (p-Nitroniline $\xrightarrow{\text{acid}}$ H-acid $\xleftarrow{\text{alk.}}$ Aniline) is less strongly adsorbed than the monoazo acid dyes, Fast Red A and Orange II; the trisazo dye Chlorazol Green BNS (Phenol $\leftarrow$ Benzidine $\xrightarrow{\text{alk.}}$ H-acid $\xleftarrow{\text{acid}}$ p-Nitraniline) is less strongly adsorbed than the disazo dyes, Chlorazol Sky Blue FF and Benzopurine 4B. The influence of a hydroxyl group not chelated with an azo group in promoting adsorption on alumina has been shown earlier by the observation that 4-benzeneazoresorcinol is more strongly adsorbed than 2:4 or 4:6-bisbenzeneazoresorcinol.[5] Neolan Red B (a chromium complex) is more weakly adsorbed than the parent azo dye, Eriochrome Red B. The solvent sometimes determines the order of separation; Benzopurpurine 4B is more strongly adsorbed than either Chlorazol Sky Blue FF or Durazol Fast Blue 8GS on filter-paper using water as solvent, but the order is reversed when aqueous methyl cellosolve acetate is used as the solvent.

Our thanks are due to the *Council of Scientific and Industrial Research* under whose auspices this work has been carried out. Details will be communicated to the *Journal of Scientific and Industrial Research*.

Dept. Chem. Technology, N. R. Rao.
University of Bombay, K. H. Shah.
May 6, 1950. K. Venkataraman.

1. Ruggli and Jensen, *Helv. Chim. Acta*, 1935, **18**, 624; 1936, **19**, 64. 2. Brown, W. G., *Nature*, 1939, **143**, 377. 3. Schönbein, *Verh. d. Naturforscher Ges. i. Basel*, 1861, **3** Teil, 249. 4. Boscott, *Nature*, 1947, **159**, 342. 5. Gore, Panse and Venkataraman, *Proc. Ind. Acad. Sci.*, 1949, **29A**, 289.

VARIATION OF DIELECTRIC CONSTANT WITH CONCENTRATION

The observed linear variation of dielectric constant[1-3] with concentration in dilute solutions of nonpolar solvents can be directly derived from the Debye-Clausius-Mosotti equation as follows:—

$$\frac{(\epsilon_{12}-1)}{(\epsilon_{12}+2)} V_{12} = p_1 + (p_2 - p_1)\,\omega_2 \qquad (1),$$

with the usual notations. Substituting the observed relation $V_{12} = V_1 + \beta\omega_2$ in (1) and solving for ϵ_{12},

$$\epsilon_{12} = 1 + 3\left\{\frac{p_1 + (p_2 - p_1)\,\omega_2}{(V_1 - p_1) - (p_2 - p_1 - \beta)\,\omega_2}\right\}$$

$$= \epsilon_1 + \frac{3}{(V_1 - p_1)}\left[\left\{(p_2 - p_1) + \left(\frac{p_2 - p_1 - \beta}{V_1 - p_1}\right) p_1\right\}\omega_2 + \left\{(p_2 - p_1) + \left(\frac{p_2 - p_1 - \beta}{V_1 - p_1}\right)p_1\right\}\left(\frac{p_2 - p_1 - \beta}{V_1 - p_1}\right)\omega^2{}_2 + \ldots. + \left\{(p_2 - p_1) + \left(\frac{p_2 - p_1 - \beta}{V_1 - p_1}\right)p_1\right\} \times \left(\frac{p_2 - p_1 - \beta}{V_1 - p_1}\right)^{n-1} \cdot \omega^n + \ldots.\text{to}\ \infty \qquad (2)$$

Since $\omega_2 << 1$ in dilute solutions,

$$\epsilon_{12} = \epsilon_1 + \frac{3}{(V_1 - p_1)}\left\{(p_2 - p_1) + \left(\frac{p_2 - p_1 - \beta}{V_1 - p_1}\right)p_1\right\}\omega_2 \qquad (3)$$

as compared with the observed relation $\epsilon_{12} = \epsilon_1 + \alpha\omega_2$

whence

$$\alpha = \frac{3}{(V_1 - p_1)}\left\{(p_2 - p_1) + \left(\frac{p_2 - p_1 - \beta}{V_1 - p_1}\right)p_1\right\}$$

or

$$p_2 = \frac{3\alpha V_1}{(\epsilon_1 + 2)^2} + (V_1 + \beta)\frac{(\epsilon_1 - 1)}{(\epsilon_1 + 2)},$$

which is identical with the expression derived by Halverstadt and Kumler[3] for $p_2(\infty)$.

Equation (2) indicates that in the case of highly polar solutes ($p_2 > p_1$) terms in the higher powers of ω_2 cannot be ignored even when ω_2 is small. Consequently in such cases, even for dilute solutions the ϵ_{12}—ω_2 plot should be a curve concave upwards. This indeed is the case for dilute solutions of nitrobenzene in non-polar solvents where the variation of ϵ_{12} with ω_2 follows the relationship $\epsilon_{12} = \epsilon_1 + \alpha\omega_2 + \alpha'\omega_2{}^2$ as observed by Smith and Cleverdon.[4]

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General Chem. Laboratories,
Ind. Inst. of Science.,
Bangalore 3,
April 12, 1950.

1. Hedestrand, *Z. Physikal. Chem.*, 1929, *B***2**, 428. 2. Le Fevre, and Vine, *J. Chem. Soc.*, 1937, 1805. 3. Halverstadt and Kumler, *J. Amer. Chem. Soc.*, 1942, **64**, 2988. 4. Smith and Cleverdon, *Trans. Faraday Soc.*, 1949, **45**, 109.

THE TRANSPIROSCOPE*
A NEW DEVICE

THE transpiroscope (text figs. 1 and 2) consists of a chamber with a metal-loop-handle at the top and an air-tight lid hinged sideways. The bottom and the lid are each provided with a glass panel. A human-hair clock-type hygrometer is located in the chamber towards the top-end. There is a groove on the right side for a safe lie of the leaf petiole. Near the top is a hole for introducing a thermometer.

With the lid of the chamber kept open, the humidity of the atmosphere is read directly on the dial of the hygrometer. The experimental leaf is then introduced *in situ* into the chamber and the lid closed over it in such a manner that the petiole lies safe on a pad of cotton wool in the side-groove. A fixed period (usually 5 minutes) is allowed for one observation. The rise in humidity (due to the water of transpiration being given off as vapour) is indicated by the movement of the needle of the hygrometer. The difference between the readings gives the transpiration value, which is then reduced to a unit value per square centimeter of the leaf area for purposes of comparison. Such determinational studies

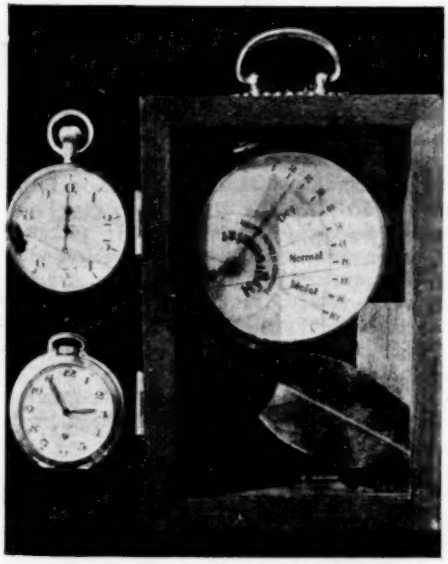

FIG. 1. A photograph of the transpiroscope at the start of an experiment at 2-55 P. M. with a *citrus* leaf *in situ* enclosed inside the chamber. Note the reading. (× 1/3).

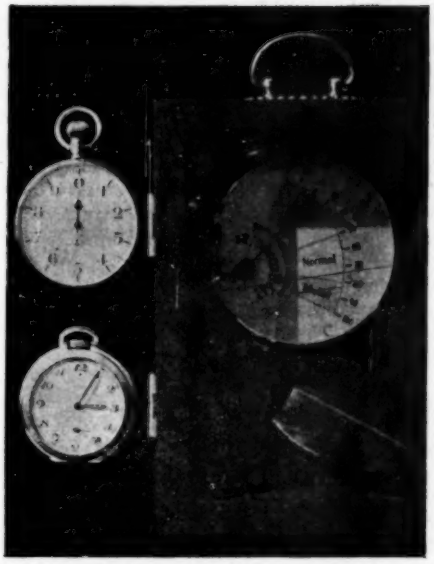

FIG. 2. The photograph of the same arrangement after expiry of ten minutes at 3-5 P. M. Note the reading now. The difference between the two readings indicates the transpiration value in terms of humidity. (× 1/3).

of transpiration can be made with ease on at least 8 leaves *in situ* per hour under natural field conditions without any elaborate arrangement. The apparatus has been found to be very portable.

My grateful thanks are due to Professor T. C. N. Singh who tested the apparatus both under laboratory and field conditions.

Horticultural Res. Institute, MISS R. SHAH.
Nagpur-Ajni (India),
December 1, 1948.

* This apparatus was devised by the author in 1940 in connection with her investigation on the comparative transpiration values of the various species of *Citrus* in the Central Provinces.

PUCCINIA KUEHNII (KRUEG.) BUTLER ON SUGARCANE IN INDIA

THE immunity of the Indian sugarcane to *Puccinia Kuehnii* (Krueg.) Butler was doubted by Butler (1918). Although there is no published record to support his contention, specimens deposited in Herb. Crypt. Ind. Orient show that this fungus was collected on *S. officinarum* in 1919 from Almora, and from

Pusa in 1926. Recently, specimens of sugarcane received for examination from Kopergaon, Ahmadnagar, Bombay showed severe infection of this fungus on leaves of sugarcane variety Co. 475. It has also been recorded in Australia, Ceylon, China, Fiji, Formosa, Indo-China, Japan, Java, Sumatra, Philippines, South Africa and Egypt on *S. officinarum*.

The type specimen of this fungus is based on a collection by Butler from Burma in 1912 on *S. spontaneum*. The teleutospores (according to Butler) were immature and scanty and have not been observed elsewhere. In the Kopergaon specimen, however, we found copious formation of these but with some minor differences. A fuller description of the fungus is therefore, presented here.

Uredia hypophyllous, rarely epiphyllous, subepidermal, linear, single or gregarious. *Spots* 1–2 cm. × 2–5 mm. with broad purple margin, which later turns dark coloured. Sori are exposed by rupture of epidermis. *Uredospores* are ovate or pear shaped, cadmium orange to xanthine orange in colour (Ridgeway), thick walled, echinulate, with two germ pores, measuring 21-40 (mostly 27–35) × 20–25 μ, borne on hyaline, long stalks, from which they break off readily. Both at the margins and intermixed are *paraphyses* which are hyaline or yellowish in colour with a light greenish tinge, with capitate, rounded heads. The dimensions of the uredospores of the collections on various *Saccharum* species are as under: —

1	*Saccharum arundinaceum*		Coimbatore	33–42 × 21–28 μ
2	,,	,,	Poona	32–38 × 22–28 μ
3	,,	*sara*	Lahore	26–38 × 18–25 μ
4	,,	*narenga*	Mussoorie	28–40 × 20–27 μ
5	,,	*fuscum*	Saharanpur	20–36 × 20–27 μ
6	,,	*spontaneum*	New Delhi	25–33 × 22–26 μ
7	,,	*officinarum*	Pusa	33–37 × 20–23 μ
8	,,	,,	Kopergaon	27–35 × 20–25 μ

These show that there is no difference in spore size of the uredospores found on various *Saccharum* species.

Teleutosori arise in the same spots as the uredospores on the undersurface of leaf. The *sori* are smaller in size than those of uredospores and after the rupture of epidermis are somewhat darker in colour. *Paraphyses* are marginal. *Teleutospores* are bi-celled, clavate or club-shaped, rounded or somewhat flattened above, narrowed below, with a slight or no constriction at the septum. Upper cell is roundish but lower cell is sometimes bulging or narrowed below. These are borne on short stalks which are not deciduous. They are Sanford's brown in colour (Ridgeway). *Epispore* is smooth, not uniformly thick, somewhat thickened at the apex and chestnut brown in colour (Ridgeway). Spores measure 30–57 (mostly 38-48) × 17-22 μ without stalks, upper cell mostly 18–22 μ and the lower 20-26 × 12–18 μ. *Stalks* 10–16 μ long. Fig. 1 shows a section of a teleutosorus with marginal paraphyses and Fig. 2 teleuto and uredospores.

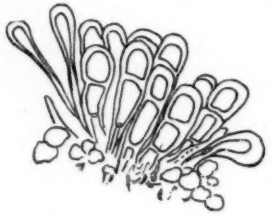

FIG. 1

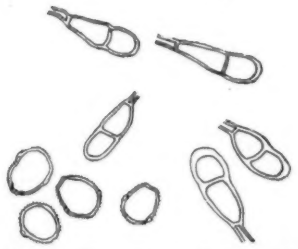

FIG. 2

FIG. 1. Teleutosorus with marginal paraphyses × 250.
FIG. 2. Teleutospores Uredospores of Puccinia Kuehnii (Krueg.) Butler × 240.

The uredospores germinate readily in water in about 6 hours; 20-25° C. being the optimum temperature. The spores lose their viability after one month's storage at room temperature (20-25°C.).

Specimens of *Puccinia Kuehnii* (Krueg.) Butler on various *Saccharum* species, show the presence of its hyperparasite, *Darluca filum* (Biv.) Cast., as has been reported by Padmanabhan and Rafay (1942) in the occurrence of this fungus on *Saccharum arundinaceum*.

Thanks are due to Dr. R. S. Vasudeva, for helpful criticism and to Dr. R. D. Rege for the material.

Division of Mycology & Plant Pathology, Indian Agri. Res. Institute, New Delhi.
March 28, 1950.

B. L. CHONA,
R. L. MUNJAL.

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NECROSIS OF THE MANGO FRUIT

Necrosis in the mango can be attributed neither to any fungal or bacterial organism nor to the effect of the commonly known deleterious constituents of brick kiln fumes, *e.g.*, sulphur dioxide, carbon monoxide, ethylene, etc. Das Gupta *et. al.* ([1,2]). A survey of the affected orchards (Verma)[5] suggested that brick kiln fumes however had some causal relationship to the necrosis. The disease could not be reproduced in any appreciable degree by burning coal (fuel used in brick kiln) in small improvised ovens in mango orchards during two successive seasons. About two dozen fruits at varying distances from the chimney got the disease, but this number out of a total of more than fifteen thousand is hardly significant. This is at variance with the findings of Sen[4] who claims to have reproduced the disease by burning coal in ovens.

The disease has now been produced in healthy mango fruits of Dasehri and Safeda varieties by injecting sterile mango juice from healthy fruits in which brick kiln fumes have been passed for some time. Injections succeeded only in fruits of size 1¼″ to 3½″ and as many as 50% developed necrosis. Injection of sterile mango juice extracted from healthy fruits served as control and had no effect on mango fruits.

An attempt was made to find out solvents other than mango juice for the constituents of the brick kiln fumes. The fumes were passed in different solvents, the solvents distilled and the residue, dissolved in sterile mango juice from healthy mango fruits, was injected in healthy fruits. Among the many solvents tried, ether and chloroform were found to absorb readily the disease inducing constituent of the fumes, ether being a better solvent than chloroform. 50% of the fruits injected with the ether-soluble portion of the fumes developed necrosis.

Three fractions have been separated from the ether-soluble constituents of the fumes. The first is sparingly soluble in cold petroleum ether, acetone, and ethyl alcohol and is soluble in ether and chloroform. It crystallizes in hexagonal form. It has a melting point of 110·5 ± 0·5 C. The second is sparingly soluble in acetone and ethyl alcohol and has a melting point of 61 °C. (uncorrected). The third fraction is a viscous mass easily soluble in acetone but sparingly soluble in ethyl alcohol. All the three fractions are soluble in mango juice. To test their reactivity, the three fractions were separately dissolved in sterile healthy mango juice and injected into healthy Dasehri and Safeda fruits. Only the first fraction was found to be reactive. 50% of the fruits injected with the first fraction became necrotic.

In 1940 Das Gupta and Verma[3] found that necrosis could be produced by injection of sterile juice from necrotic mangoes into healthy fruits. The microscopic appearance, chemical behaviour, and reactivity on mangoes of the ether-soluble constituents obtained from the juice of necrotic fruits seem to be similar to those of the ether-soluble constituents of brick kiln fumes.

Experiments have shown that if injections are made in regions of the fruit, other than the tip, necrosis is not produced; but the seed is killed as in advanced cases of natural necrosis.

How exactly the constituents of the brick kiln fumes cause necrosis is not known. There seem to be two possibilities. It may be absorbed directly by the fruits; or by regions other than the fruits and subsequently translocated to the fruits. The latter is the more likely.

Department of Botany,
Lucknow University,
March 8, 1950.

S. N. Das Gupta.
G. S. Verma.
S. C. Agarwal.
J. N. Rai.
S. N. Iyer.

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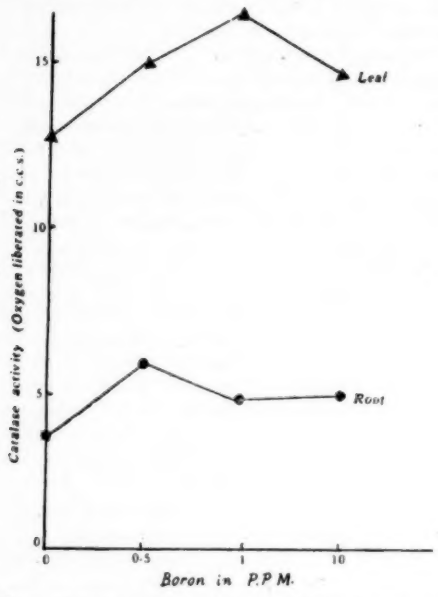
THE EFFECT OF BORON ON THE CATALASE ACTIVITY OF RICE PLANT

Alexander[1] found that boron deficiency increased the catalase activity in squash plants, whereas Bailey and Mc Hargue[2] reported that the addition of boron upto 1 p.p.m. increased it. As there was no general agreement, the present study on the effect of boron on catalase activity in rice plant was undertaken.

Rice seeds of C.H. 45 type supplied by the Central Rice Research Institute, Cuttack were sterilized by dipping for 10 minutes in 0·1% $HgCl_2$ solution. The washed seeds were germinated in sand and the seedlings were transplanted in glazzed pots, containing sand The composition of the nutrient solution was as follows: KH_2PO_4 — 1·25$_g$, Ca $(NO_3)_2$ $4H_2O$—4·27$_g$, $MgSO_4$. $7H_2O$ — 2·88$_g$, $(NH_4)_2SO_4$ 0·38$_g$ and 1 ml. of 1% Ferric tartrate solution

in 1 litre of water. $MnCl_2$ and $CuCl_2$ were added to the culture solution in concentrations of 1 p.p.m. Mn and ·01 p.p.m. Cu.



Effect of boron on the catalase activity of roots and leaves of rice plant

The treatments, in triplicate, were 0·5, 1 and 10 p.p.m. of boron per pot added as boric acid in addition to a control with no added boron. Catalase activity of leaves and roots were determined separately at the end of 10 weeks[3,4] and are given in the Fig. as c.c.s oxygen liberated from dilute (about 4 vols.) hydrogen peroxide at the end of 5 minutes by macerated extract corresponding to 0·1 g of the plant tissue.

It may be seen that catalase activity in both the leaves and the roots increased when boron was added. Activity was less in roots than in leaves and far from being uniform.

Further work is in progress.

Grateful thanks are due to the Utkal University for the award of a Research Fellowship and to Dr. B. Samantarai for his kind encouragement and guidance.

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Ravenshaw College,
Cuttack 3,
December 19, 1949.

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STUDIES ON THE OVARIES OF *POLYNEMUS TETRADACTYLUS* SHAW IN RELATION TO ITS SPAWNING.

P. Tetradactylus, known locally as "ravas". occurs seasonally in the Bombay waters, from January to April, and July to September. The mature and the spent forms are found in plenty, the immature and maturing ones being relatively few. Periodic plankton collections show that the larvæ and post-larvæ of this fish are found in the shore waters practically all the year round, suggesting that the fish breeds more than once a year.

The ovaries of immature fish measure 4·5″ in length and 40 gms. in weight. The immature ova, with diameters varying from ·10 mm. to ·40 mm. are yolkless and transparent, with a distinct central nucleus in each.

The maturing ovaries are 5·5″ long and weigh 60 gms. on an average. The ova are opaque, being packed with yolk granules and a few oilglobules. Yolk is deposited in the form of a thin granular layer along the periphery, and fills the enlarging ovum. Diameters of the maturing ova vary from ·45 to ·68 mm.

The mature fish, possesses extensively developed cream-coloured ovaries which vary from 6″ to 10″ in length and from 100 to 300 gms. in weight. The mature ova appear transparent, on account of the vacuolated condition of the yolk, and contain usually a single, large, shining oil-globule. Their diameters vary from ·70 to ·85 mm.

The spent fish which resembles the mature form in its body-length, has its ovaries distinctly flacid and reddish in appearance. They contain a large number of empty follicles from which "ripe" ova have been dislodged and spawned. A few ripe ova representing the remnant of the spawned crop are seen in the wrinkled ovarian sacs.

"Ripe" ova appear opaque rather than transparent, due to the breaking down of the vacuolated yolk into a paste-like semi-fluid diffused mass surrounded by a thin, clear, perivitelline space. The ova of the mature fish pass through the "ripening" stage prior to their spawning.

The fact that the mature fish contains only two types of ova, mature and immature, suggests that the spawning may not occur more than once a season. And since mature and spent fish are found simultaneously in two

consecutive seasons, it follows that the fish spawns twice a year.

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Bombay,
March 29, 1950.

ADDENDUM TO LIST OF CHROMOSOME NUMBERS IN ECONOMIC PLANTS

THE somatic chromosome numbers have been determined in the following plants. These 2*n* numbers were obtained from sections of root tips and are based on maximum numbers counted from many intact cells in mitotic metaphase. As recorded in the previous communication[1] these counts show the prevalence of regularity and polyploidy in the chromosomes of Angiosperms. In all the species, the numbers recorded tally with counts recorded earlier for some of the related species. To bring out these features, the basic number of each genus is given in brackets along with the number newly recorded.

	Species	2*n* number	Basic number of genus
	LEGUMINOSEÆ		
1	*Indigofera tinctoria* Linn.	16	(8)
2	*Tephrosia purpurea* Pers.	24	(8)
3	*Cassia obtusa* Roxb.	28	(7)
4	*Cassia javanica* Linn.	28	(7)
5	*Glycine javanica* Linn.	20	(10)
6	*Prosopis glandulosa* Torr.	26	(13)
	GRAMINEÆ		
7	*Iseilema laxum* Hack.	36	(9 & 12)
8	*Enteropogon monostachyos* Schum	20	(10)
9	*Amphilophis foulkesii* C.E.C. Fischer	20	(10)
10	*Arundinella setosa* Trin.	20	(10)
11	*Panicum psilopodium* Trin.	54	(9)
12	*Setaria sphacelata* Stapf & Hubbard	36	(9)
13	*Digitaria smutsii* Stent.?	18	(9)
14	*Digitaria marginata* Link.	54	(9)
15	*Phragmites karka* Trin.	36	(12)
16	*Garnotia scoparia* Stapf.	20	..

I wish to acknowledge my indebtedness to Sri. S. Sampath, Cytogeneticist, for his guidance and to the Government Lecturing and Systematic Botanist for the materials supplied for this investigation.

Cytogenetics Laboratory, K. RAMANATHAN.
Agricultural Res. Institute,
Coimbatore,
March 16, 1950.

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A NEW FIELD HOST OF *MICROBRACON HEBETOR*, S.

Microbracon hebetor, S. (Hymenoptera, Braconidæ), the well-known ectophagous larval parasite, essentially, of the Rice and Flour moth, *Corcyra cephalonica* St., infesting a variety of stored food and other commodities in India, has recently been found here to extend its host preference to yet another important field pest, *viz.*, *Sesamia inferens*, Walk. (Lepidoptera, Noctuidæ), whose caterpillar is a rather serious stem-boring insect of irrigated Ragi (*Eleusine coracana*), and other Graminaceous cereal crops like Jola (Jowar), Sugarcane and Wheat. The other field hosts of *M. hebetor* previously recorded in Mysore are (i) the *Lab-lab* (Avare) pod borer, *Adisura atkinsoni*, M., and (ii) the jola earhead webbing caterpillar, *Stenachroia elongella*, H.—hosts that live and develop under cover.

Prior to oviposition, *Microbracon hebetor* paralyses the Ragi stem-borer larva (4th instar upwards); eggs are deposited all round the host-body; resulting parasite larvæ are pink conforming to the colour of the host, feed externally and pupate on and around the host-larva (which by now is dead); 11-27 cocoons are found per host arranged lengthwise lying end to end and overlapping in the narrow cavity of the host-tunnel in the stem. In April-May, the main breeding season of *Sesamia inferens* in irrigated Ragi, *M. hebetor* completes its life-cycle in 10-14 days ± 9 hrs. at a temperature ranging from 68-97 °F. The emerging adults are active, feed on dilute honey and copulate; number of females and males almost equal, in one case, however, a large majority of female progeny was obtained (16:3); colour and size vary even in one and the same lot. Naked, exposed and partially exposed host-larvæ are also readily parasitised in the laboratory.

Field liberations of *Microbracon hebetor*, against *Sesamia inferens* infesting irrigated Ragi, are being undertaken.

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Agric. Coll. & Res. Inst., B. KRISHNAMURTI.
Bangalore,
May 1, 1950.

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ON THE OCCURENCE OF *GLOSSOBALANUS PARVULUS* (PUNNETT) ON THE OKHAMANDAL (KATHIAWAR) COAST

THREE species of Balanoglossids, *viz.*, *Glossobalanus minutus*, *Glandiceps hacksi* and *Saccoglossus* (=*Dolichoglossus*) *bournei*, were recorded by Menon (1903) from the Madras coast. Rao (1934) reported the presence of *Chlamydothorax* (=*Ptychodera*) *ceylonica*, *Ptychodera minuta*, *Glandiceps hacksi* and a new species: *Chlamydothorax* (=*Ptychodera*) *krusadaiensis*, from the Krusadai Island (Gulf of Mannar). The writer is not aware of any later additions to this list of the Balanoglossid fauna of India, except for the record of an unidentified Giant Balanoglossid from the Galaxea Reef in Krusadai Island (Rao and Rao, 1949).

During studies of the fauna of the mud flats, east of Aramda (Okhamandal District-Kathiawar) half a dozen specimens of *Glossobalanus parvulus* (Punnett) were obtained from the exposed beach at 3·5 tide in September, 1947. The whole area was covered over with a deep layer of fine mud, and the specimens were collected while digging for burrowing worms. The mounts of 'castings' usually seen near the burrows of Balanoglossids, which are helpful in locating their abodes, were not noticeable here. The specimens ranged from 15 mm. to 28 mm. in length. More specimens were collected later from the exposed mud flats of Balapur Bay in Beyt Island (Gulf of Cutch).

Glossobalanus parvulus was described by (Punnett, 1906) from the Bahlos Atol in Maldive Islands. Van der Horst (1939) gives this Atol as its only known habitat. The present one is the second record of this species, and the first record of a Balanoglossid from the Okhamandal area, and possibly from anywhere on the West Coast.

My sincere thanks are due to Dr. S. L. Hora, Director, Zoological Survey of India, for affording help in the identification of the specimens and Mr. S. P. Naidu for assistance during collection tours.

Zool. Surv. India Labs., Calcutta,
March 3, 1950.

T. V. R. PILLAY.

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HYBRID MAIZE FOR THE GOKAK CANAL TRACT IN THE STATE OF BOMBAY

MAIZE, *Zea mays* L., is cultivated in two small zones in the State of Bombay, one of which is the Gokak Canal tract with an area of about 15,000 acres under the crop. Systematic breeding for evolving suitable hybrids for this tract was undertaken on the American lines at Arbhavi (District Belgaum) in the year 1942-43. The work has resulted in two hybrids, *viz.*, (1) $I_5 \times S_{23}$ and (2) $L_5 \times S_{23}$ which have yielded, on an average, 15 per cent. more grain than the local variety in 5 large scale trials. The inbred parents, I_5 and L_5, come from the local variety and S_{23} from the African variety, Sahara. The hybrids are very similar to the local variety in grain characters and period of maturity which is about 95 to 100 days. The theoretically expected yield of the three way cross,

$$(I_5 \times L_5) \times S_{23}$$

is likely to be as good as of the single hybrids.

Office of the Dy. Director of Agric. (Crop Res.), B.S., Poona 5,
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OCCURRENCE OF GREEN EAR STAGE IN SORGHUM

GREEN ear stage symptoms of two different types on *jowar* were observed, one at the College of Agriculture, Poona, and the other at Gothan in Olpad Taluka of Surat District during November, 1949. The individual spikelets in the panicle were transformed into

Fig. 1

narrow, long, leafy structures measuring 1·30×0·2–2 cm., each panicle consisting of 9–42 leafy structures. The appearance of these structures was characteristic of a typical infection by downy mildew on *jowar* (*Sorghum vulgare*). Unlike its counterpart in *bajri* (*Pennisetum typhoides*), these leafy structures appeared to grow from a central basal point on the floral stalk in the form of a whorl. There was complete suppression of the development of ovaries (Fig. 1, A–E). The leafy scales showed browns treaks which on examination revealed presence of oospores embedded in mesophyll tissues, arranged linearly in long rows and separated from each other by the vascular tissues. The conidial stage was evanescent.

The second type of symptoms referred to above results in transformation of the entire panicle into an appearance not at all dissimilar from the characteristic green ear found in *bajri*. The characteristic whorled appearance encountered in the first type of symptoms described above was absent. The green scales

Fig. 2

were much shorter and tubular, measuring 0·2–5 × 0·1 cm. Each proliferated spikelet appeared to retain its individuality in the panicle (Fig. 2).

Further work is in progress.

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March 6, 1950.

MYSORE CARDAMOM OIL

Rao, Sudborough and Watson[1] recorded only some physical constants of Mysore cardamom oil. The results of a more extended investigation of its ingredients are here reported.*

The cardamoms from Sakalaspur District in Mysore were steam distilled, and it was found that the sundried first quality yields a higher percentage of essential oil than the others (3·75 per cent. by weight of the whole fruit and 4 per cent. by weight of the seeds). The essential oil had the following physical constants: n_D^{25}, 1·4615; sp. gr. at 26° C. 0·9250; $(\alpha)_D^{25}$, +12° 52. Such low values for optical rotation have not so far been recorded for Mysore oils. Rao, Sudborough and Watson[1] gave the value as + 15·1° to + 44°. Gildmeister and Hoffmann[2] have, however, recorded + 12° to + 15° for wild cardamom oil from Ceylon.

The aqueous portion of the steam distillate on extraction with chloroform gave ·5 per cent. more of the essential oil and had the following physical constants: n_D^{25}, 1·4605; sp. gr. 0·920; $(\alpha)_D^{25}$, 0. The oil has a very penetrating odour and contains 80 per cent. cineol.

Its ester value is rather low, being only 38·8 (Rao Sudborough and Watson[1] give the ester value as 96·5 to 156·4). The acetylated product also had the low value 39·5 indicating that the percentage of free alcohol (probably terpineol) was low.

Fractions yielding high proportions of cineol[3] (62 15%) and terpenyl acetate[4] (26·96%) have been obtained. None of the fractions gave tests for aldehydes and ketones.

The lævo rotation of the earlier fractions is probably due to the presence of a small quantity of l-sabinene.[3]

Our thanks are due to Dr. B. H. Iyer for help rendered in the preliminary stages.

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April 3, 1950.

* The work was undertaken at the instance of the Government of Mysore.

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REVIEWS

Annual Review of Microbiology.—Vol. II. By C. E. Clifton, S. Raffel and H. A. Barker. (Annual Reviews, Inc., Stanford, California), 1948. Pp. 532. Price $ 6·00.

The second volume of this new *Annual Review* discusses eighteen topics of interest to microbiologists in general. A discussion on the phylogenical, morphological, taxanomic and ecological aspects of yeasts is given by Mark and Phaff. Lindegren, the well-known pioneer in the unexplored field of the genetics of fungi, has presented a critical review of the subject. A useful and stimulating review on the metabolism of malarial parasites by Moulder will be of interest to those interested in the study of pathogenic plasmodia. The rapidly expanding field of antibiotics has been brought up to date by Bailey and Cavallito who have emphasised the mode of action and the development of resistance in relation to antibiotics. Of particular interest is the review of Hotchkiss on the mode of action of chemotherapeautic agents. The controversial topic of biological fixation of nitrogen has again been reviewed by Vitanen, one of the principal workers and contestants in the field. Other subjects discussed in the review include:—Microbiology of soil by Smith, Microbiology of drinking water and sewage by Smit. Chemical disinfectants by Wyss, Bacterial plant pathogens by Burkholder, Neurotropic viruses by Schultz, Spirochetes by Davis, Nature of antibodies by Campbell, Pathogenic streptococci by Ramelkamp and Dingle, Inheritance of immunity by Gowen, and Growth factors of micro-organisms by Koser. Each of the reviews presented in the volume is comprehensively documented by references to original papers. We are confident that the volume will receive the same warm reception which its sister volumes have received in the past.

Advances in Enzymology, Vol. IX. Edited by F. F. Nord. (Interscience Publishers Inc., New York), 1949. Pp. x+730. Price $ 9·00.

This volume contains discussions of twelve topics covering a variety of biochemical and physiological subjects. It is refreshing to note that the proportion of contributions from laboratories other than American is increasing, five out of the twelve emanating from England, Sweden and Germany; this is indicative not only of the return of the normal conditions for scientific work in Europe, but also of the persuasive powers of Editor Nord who has a genius for organising such "Advances".

Physico-chemical aspects of enzyme reactions are covered by two reviews on (1) Some aspects of reversible step reactions and (2) Kinetics of biological reactions with special reference to Enzyme processes. The widely scattered literature on the subject of the Photochemistry of enzymes, proteins and enzymes has been reviewed by Mclaren; particular importance will be attached to this helpful review by those interested in the rationalised production of lethals and mutations in plants and animals by ultra-violet irradiation.

Walker, one of the earliest pioneers in elucidating the mechanism of acid formation by fungi, has presented an able and clear review of the confusing literature pertaining to this subject. Glick's short contribution on the Principles of enzymic histo- and cytochemistry will be welcomed by the more enterprising cytologists interested in the detection, location and estimation of enzymes in tissues and tissue fluids. Other contributions include Industrial Biosyntheses.—Part I: Fats, by Hesse, Enzyme activity in frozen vegetable tissue, both subjects of industrial interest.

Mann's masterly review on the metabolism of semen is of great practical interest in view of the expanding practice of artificial insemination as a means of animal breeding. The mechanism of the fertilisation of Metazoa by Runnström, the nature of viruses by Lauffer and others, Chemistry and enzymology of nucleic acids by Schlenk, Nitrogen metabolism of higher plants by Street, are the other topics presented in this volume.

The "Advances" will continue to be eagerly welcomed by all investigators interested in the varied aspects of biochemical research.

The Theory of Inbreeding. By R. A. Fisher. (Oliver & Boyd, Edinburgh and London), 1949. Pp. 120. Price 10*sh.* 6*d.*

Many books have been written on the advantages of inbreeding and the methods followed in certain experimental farms but few have provided a satisfactory quantitative approach to the various problems of inbreeding. In what way one method of inbreeding is better than the other? In how many generations can

we expect a desired progress by following a particular method of inbreeding? What happens when a certain programme becomes irregular due to a desired offspring being not available? What is the best course to follow in such cases? On a solution of these problems depends the choice of a successful breeding programme leading to a desired progress in a minimum number of generations.

The importance of inbreeding is not sufficiently realised. The process of improvement is undoubtedly slow. But 'the forty-nine years which have elapsed since the discovery of Mendel's work would have sufficed to supply the present generation of animal breeders material of utmost value had the adoption of inbreeding programmes not been delayed by prejudice and inertia, reinforced perhaps by superstitious fear.' Recently, by following the cyclical operations of choosing a suitable foundation stock, inbreeding to produce nearly homozygous lines and crossing chosen lines, considerable improvement has been achieved in maize yield. Such an improvement was responsible for a substantial increase in the national income of the United States of America. This resounding success makes it certain that the theoretical and practical aspects of inbreeding should be studied in greater detail. R. A. Fisher has given a lead to a comprehensive programme of research in the theory of inbreeding by discussing in his book various designs of inbreeding programmes, and the relative speed with which homozygosity is achieved in each case.

For experimental purposes a line can be inbred while maintaining segregation in a desired number of factors. Such inbred lines provide controlled comparisons of genetic differences ascribable to single factors or an interaction of two or more. They also preserve living genetic material which may be readily available for comparison with genes discovered later. Otherwise a good deal of preliminary experimental work would be necessary. A third advantage is that inbred lines supply continuous data for linkage studies. By proper planning, all possible linkages of a number of known factors can be studied by maintaining replicated inbred lines, in each of which a relatively fewer number of factors are kept segregating. The number of families needed to maintain a segregating inbred line depends on the expected number of eligible matings available in the number bred The mathematics leading to the evaluation of this expected number is given in Chapter II of this book. This obviously depends on the number of factors kept segregating and the number of young ones born to a family.

The third Chapter deals with the progress towards homozygosity. The mathematics involved in this Chapter is, indeed, complicated but is presented in such a style that is easily understood by non-mathematicians. The idea is simple. Starting from a certain number of initial matings available it is easy to determine the expected number of various types of mating available in the next generation. This is simply given by the product of a row vector f_0 giving the initial frequencies and a matrix A called the generation matrix. By applying the same rule the frequencies f_n in the n-th generation are given by the product $f_0 A^n$. To determine A^n the matrix A is first reduced to the canonical form

$$A = C \begin{pmatrix} \lambda_1 & & \\ & \ddots & \\ & & \lambda_p \end{pmatrix} C'$$

where $\lambda_1, \cdots, \lambda_p$ are the latent roots of the matrix A and C is an orthogonal matrix so that $CC' = I$ in which case

$$A^n = C \begin{pmatrix} \lambda_1^n & & \\ & \ddots & \\ & & \lambda_p^n \end{pmatrix} C'$$

If the roots correspond to the matrix obtained by omitting the frequency of matings of the type aa × aa (doubly homozygous), then the speed with which homozygosity is reached depends on the convergence to zero of the n-th power of the highest root. To determine the relative speeds of various inbreeding programmes only the dominant latent roots of the corresponding generation matrices need be compared. A simple calculation on this basis reveals that 7 to 8 generations of selfing is equivalent to 23 or 24 generations of sib-mating.

The same principle is used to measure the irregularity or retardation due to intercalating a mating of a different type in a certain inbreeding programme when a desired offspring is not available.

In Chapter IV are considered various systems of inbreeding and their generation matrices. The results of mating a particular phenotype D and not D and the condition of a locus on the same chromosome as a segregating dominant have been discussed in relation to sib and parent offspring matings. The most important sections of this Chapter are those concerning polysomic segregation. In this case further complications arise due to double reduction but the algebra is same

as that used earlier. In the case of tetraploids and hexaploids it is seen that approach to homozygosity is slower than that of diploids for all types of inbreeding.

In an appendix are considered the most efficient designs of inbreeding for species bearing one offspring at birth.

The first large-scale systematic study on hybrid vigour was made by Darwin and published in 1876. Although much experimental work was carried out since then there is no well established theoretical explanation as to why when two dissimilar inbred varieties are crossed the offspring shows hybrid vigour. Dominance of certain genes offers a good explanation but recent experiments have shown that this does not offer the complete explanation. There is a good deal of research work to be done in this direction. Hybrid vigour has an important part to play in animal and plant improvement. Inbreeding is an essential step in effecting such an improvement. R. A. Fisher has given in this book a comprehensive treatment of the consequences of various systems of inbreeding. This is, indeed, a great boon to future research workers engaged in problems of animal and plant improvement.

C. RADHAKRISHNA RAO.

High Polymeric Chemistry. By W. S. Penn. (Chapman & Hall Ltd., London), 1949. Pp. 473, Illustrated. Price 36*sh.* Net.

The chemistry of high polymers is becoming an important branch of study in view of its close relationship to industrial processes on which the newer plastics are based. A high polymer is a macro-molecular structure synthesised from simple organic substances, the monomers, by poly-condensation or polymerisation reactions. Knowledge of the chemistry of these reactions is yet scanty but is advancing rapidly and continually. The book fulfils the need for a readable account of the increasing flow of new information on the subject.

Information in the first three chapters of the volume covers the nature of macro-molecules and fractionation of polymers; theories of polymerisation reactions and methods in use for following up and completing these reactions; study of the shape and structure of high polymeric substances by the Electron microscope and X-ray analysis. In Chapter 9, the properties of high polymers are explained on the basis of their molecular structure and the more important features which decide their chemical and physical properties indicated.

The chemistry of polymerisation of styrene, methyl styrene, dichlorostyrene, ethylene, isobutylene and acenaphthylene are dealt with in the fourth chapter. The structure, preparation, and commercial aspects of polyvinyl chloride, polyvinyl acetate, polyvinyledene chloride and co-polymers, polyvinyl acetals, polyvinyl pyrrolidones, polytetrafluoroethylene, polymethyl methacrylate and poly allyl compounds are described under "vinyl" polymers. This is followed by an account of the most important reactions of unsaturated hydrocarbons, the specific influences in the polymerisation of Dienes and the structures of the resulting synthetic rubbers.

Fibre forming materials like nylon, polyurethane and terylene as well as thiokol rubbers and alkyds are dealt with under "Condensation" Resins. Natural high polymeric substances like cellulose and protein are considered in relation to their use as plastics and synthetic fibres in the next two chapters. Mention is made of allyl starches. The reactions leading to the formation of phenolic and amino plastics and theories regarding their structures are then presented. The organo-silicon esters, the silicones, also receive attention.

The methods of preparation of monomers are described in Chapter 15. Due emphasis is not, however, placed on the commercial methods followed.

The author rightly concludes that there is unending possibility for research in high polymers, and indicates possible trends of future lines of work on the subject, such as improving known polymers; developing new polymers; new techniques of production, *e.g.*, low temperature polymerisation, suspension polymerisation, etc.; new applications of polymers and new methods of synthesis of monomers.

The book is an attempt to present the existing basic literature on high polymer chemistry. It is specifically directed to the "Chemical" rather than the "Plastics" aspect of the subject. Mathematical considerations of the theories of polymerisation have been avoided in the work and the processes explained in simple terms. The author touches the fundamental background of the chemical factors in the preparation, properties and use of synthetic and natural high polymers. References given at the end of each chapter for more detailed reading add to the value of the volume.

N. SRINIVASAN.

The Fundamentals of Electromagnetism. By E. G. Cullwick. (Camb. Uni. Press), 1949. 2nd Ed. Pp. 327. Price 18*sh.* net.

Every teacher is familiar with the confusion in the minds of students regarding the different systems of units in Electricity and Magnetism—the electrostatic, the electromagnetic and the practical units—which make the calculations none too easy. Much of this confusion is due to the fact that the orthodox text-books in the subject follow the convention of starting with a definition of magnetic poles and electric charges as real entities and with the assumption that the fields associated with the magnetic poles and the electric charges are unconnected with each other. The book under review boldly gives up this conventional method and bases itself on the fundamental facts of modern physics.

Starting with the electron—the fundamental and indivisible unit of electric charge of modern Physics—as a physical reality, the author develops the ideas of electrostatic field, electric potentials and electric currents of different types along with the related quantities. The magnetic field and the laws of electro-magnetic induction are dealt with as associated properties of a group of electrons in motion. In the beginning itself the inter-relationship between the different systems of units is stressed and the Metre-Kilogram-Second (MKS) system is introduced.

The author has eminently succeeded in presenting the fundamental facts of electromagnetism, electromagnetic induction and electromagnetic waves in a manner, which is simple and lucid and yet preserves the essential unity and coherence of the subject as a whole. The student who understands the basis of the MKS system of units will find it very easy to work out problems in the subject. The book will no doubt be found to be highly useful to the Physicist and Engineer alike.

C. S. V.

Electric Power System Control. By H. P. Young. Third Edition (Revised and enlarged). (Chapman & Hall), 1950. Pp. 456. Price 28*sh.*

This is No. XI of a very useful series of Monographs on Electrical Engineering published by Messrs. Chapman & Hall. First published in 1942, the book meets a very important need of both practising Engineers in the field of power system operation and students specialising in power engineering. This is indicated by the fact that the book has already run into a third edition.

In this edition, the author has added two chapters on automatic protective systems—an important link in the complete set up for an electric power control. An efficient and economic operation, in the largely interconnected power systems of to-day, requires the use of automatic protective systems for machines as well as transmission and distribution lines. This subject has been very lucidly and logically dealt with by the author in the last two chapters. Other matters dealt with in a coherent way include: parallel operation of generators; automatic regulation both for voltage and power factor control ; automatic devices for accurate synchronizing of large turboalternators; large capacity and high speed circuit breakers, including air-blast circuit breakers, and improved system design, by use of reactance, for the control of power; automatic and remote control of voltage and power factor in interconnected systems; and use of supervisory control of systems for centralized control in large interconnected systems.

The book is an authentic survey of all contemporary literature on the various aspects of power system control. The useful bibliography at the end of the book has been brought up-to-date in each chapter. The usefulness of the book in the practical field and for students cannot be overemphasized.

C. S. Ghosh.

Elements of Internal Combustion Turbine Theory. By H. T. Adams. (Published by Cambridge University Press), 1949. Pp. 178. Illustrated by diagrams. Price 16/-.

The author of the book is Senior Lecturer in Mechanical Engineering at Canterbury University College, New Zealand. He became known as author of "The Aircraft Gas Turbine," a compilation of lectures, which were given by him at Lutterworth. The two volumes were distributed amongst official technical bodies, *e.g.*, N. G. T. E. Pyestock in England. Their content has been enlarged and modernized and forms now the book being reviewed here.

After a brief introduction into the fundamentals of the gas turbine, and a very short historical review on the development, the author sets out the thermodynamic relationships governing the theoretical cycle. Due consideration is given to the effects of compressibility on a gas flowing through a nozzle or an orifice. The next three chapters deal with compressors, the centrifugal and the

axial flow compressor in all their aspects, such as theory, design, performance estimation and engine operating line. After dealing in the next chapter with the turbine and with aerodynamic properties of turbine blades methods are described of stressing the component parts of gas turbines. The important subject of vibrations forms another chapter, mentioning blade vibrations, impeller vibrations, and critical speeds of rotors. A further and very useful chapters describes the overall performance estimation for full and part load with the inclusion of corrections for data found by tests to standard atmospheric conditions. A further chapter gives an introduction to heat exchange and heat exchangers and their design, and to the technique of inter-cooling. The subject of combustion, the combustion chambers, nozzles, etc., are mentioned briefly. For a second edition an index and a bibliography would be a considerable improvement. Otherwise the book is very useful as a short introduction containing information which is not available in most of the technical books in the subject published till now.

H. A. HAVEMANN.

Water in the Physiology of Plants. By A. S. Crafts, H. B. Currier and C. R. Stocking. (Chronica Botanica Company, Waltham, Mass., U.S.A. Macmillan & Co., Calcutta), 1949. Pp. xxi+240. Price $ 6·00.

Plant physiologists should be thankful to the authors of this monograph for bringing up to date (1949) all the relevant literature on the subject in one concise volume. The only book in English on this subject is that of Maximov published in 1929. The present book is not a mere compilation but deals with the subject in a coherent, synthetic and critical manner.

The ten chapters of the book deal with the usual topics of osmosis, osmotic relations and uptake, movement and loss of water in plants. In Chapter II, the structure of water has been specially dealt with, which is perhaps the first instance in a book on plant physiology. This and the next chapter on solutions emphasise the importance of the peculiar properties of water and aqueous solutions in explaining the many abnormalities of the behaviour of water in plants. Chapters IV, V and VII deal with Osmosis. Chapter VI, on the intracellular distribution of water, discusses water as a constituent part of the cell and the binding forces due to cell colloids acting upon it. The chapter on active cell water relations (Ch. VIII) emphasises the active part played by protoplasm in the control of water and its distribution in the plant body. Uptake, movement, retention and loss of water comprise the last two chapters and can be profitably read by the botanist and the agronomist alike. Each chapter finishes with a lucid summary which is useful to the student in giving him a proper perspective. The text is aptly illustrated and wherever necessary the authors have referred to the analytical methods employed.

The book is primarily intended as a reference work by the authors who hope "that its reading will not be so tedious as to preclude its use in the classroom". But too thorough a knowledge of physical chemistry has been assumed of the student and it will be rather tough reading for the under-graduate classes. More than 800 papers have been reviewed and the monograph with its comprehensive bibliography will make an excellent reference book for the post-graduate research workers in plant physiology. N. N. N.

Annual Review of Biochemical and Allied Research in India, Vol. 19. (Society of Biological Chemists, India), 1950. Pp. 76. Price Rs. 3 or 6 *sh.*

This seventy-six page Annual Review of Biochemical and Allied Research in India for 1948 which has made its belated appearance in 1950, catalogues the researches without any pretentions to appraise critically the work, which, judged by international standards, will remain unspectacular, inconsequential and third rate.

Palaeobotany in India

The latest number (VII) of Palæobotany in India, a Bulletin of Current palæobotanical research, issued by the Birbal Sahni Institute of Palæobotany, contains abstracts of more than 80 items of research, dealing with fossil plant material,—macro and micro—found in rocks of different ages in India ranging from the Pre-Cambrian to the Pleistocene. The Bulletin is an impressive record of the nature and variety of palæobotanical studies being conducted in this country and reveals the importance of such studies from the botanical, stratigraphical and geological points of view. It is, however, sad to see that this first number of the Bulletin to be issued by the newly founded Institute of Palæobotany has had to open with the Obituary Notice of the eminent Palæobotanist, Prof. Birbal Sahni, to whose wholehearted initiative and endeavour the Institute owes its very existence.

Sound Absorbing Materials. By C. Zwikker and C. Koston. (Elsevier Publishing Company, Inc., New York), 1949. Pp. 174. Price $3·00.

The study of sound absorbing materials, both theoretically and experimentally, forms an integral part of the acoustical design of auditoria and studios as well as of the manufacture of new and better materials. The book under review considers these problems in a thorough and exhaustive way and, therefore, would prove of great value to acoustical engineers and to those who design and make construction materials. The treatment adopted is on the basis of the well-established concept of the normal acoustic impedance of the material and is analogous to the electrical transmission theory. The relevant mathematics has been completely developed throughout the book, thus making the treatment rigorous enough to satisfy the needs of a theoretical worker. Also, the practical problems that arise during design and construction have been constantly kept in view and, wherever possible, graphical representations have been given to facilitate the understanding and use of the analytical equations.

The book contains eight chapters. The subject-matter for each chapter is well chosen and the style of presentation is good. Chapter I outlines the theory of sound absorption by homogeneous media. After deriving the general equation for the impedance of an infinite medium, the particular cases of a finite medium loaded with a complex impedance and by a rigid wall are discussed. These are then extended to the more general case of an impervious medium with internal friction. The interesting feature of this chapter is the geometrical representation of the analytical equations developed. Chapter II deals in detail with the thermal and viscous effects of the porous media thus taking cognizance of the behaviour of practical materials. Kirchhoff's theory, which takes into account the viscous forces and thermal conductivity, is developed and its consequences are brought out. Chapter III deals with the absorption of sound by homogeneous, porous and elastic layers. The phenomenon of acoustical double refraction exhibited by these materials is explained. Mention is also made of the two interesting cases of complete coupling and complete decoupling of the doubly refracted waves and the results are geometrically represented. Chapter IV outlines the measurement of elementary material constants while Chapter V describes the measurement of normal acoustic impedance. Chapter VI discusses the experimental results conducted both with artificial samples and with commercial materials of different types, and interprets the results, wherever possible, in the light of the theoretical analysis given in the earlier chapters. Chapter VII considers the theoretical as well as the practical aspects of absorption of sound by single resonators. The more general cases of perforated panels and panels with slits backed by absorbing material are discussed and design charts are provided for these cases with illustrations. The last chapter considers the problem of oblique incidence and points out the complications involved in the theoretical analysis and in measuring techniques.

Professor Zwikker, the senior author of this book, and his colleagues have made valuable contributions to this branch of acoustics. There can be no doubt that this book fulfils its aim admirably and it is hoped that it will stimulate further thought and work along the directions indicated.

N. B. B.
D. L. S.

Hand Book of Aerial Mapping and Photogrammetry. By Lyle G. Trorey. (Cambridge University Press), 1950. Pp. xvi + 178. Price 25 *sh.* net.

The author, with characteristic humour, mentions in his preface that his presentation of photogrammetry is not very unlike the Chinese practice of putting the roof on the house before they build the rest, claiming with some reason, that by so doing they are able to carry on the work without any interference from the weather !

The theory of perspective geometry is treated in some detail in the first Chapter just to provide the minimum amount of scaffolding to support the roof. The rest of the theory is presented mainly in the form of exercises or worked examples.

Besides perspective geometry, the opening Chapter deals with anharmonic ratios, and the Scheimpflug condition which one meets with in the operation of epidiascopes, rectifiers and the like. The second Chapter opens with a classification of air-survey photography into (1) ground survey photographs which are usually taken with the optical axis accurately horizontal, and the plate therefore vertical, (2) high or horizon obliques (in which the optical axis is tilted suitably to include the visible horizon), and (3) low or non-horizon

obliques secured by further depressing the optical axis till the horizon no longer appears in the picture. The rest of the Chapter deals with the methods adopted for the measurement of angles from obliques. Perspective grid and four point methods, measurement of height from a single oblique, verticals: fundamental conditions of cover, parallax and stereoscopes, parallax and elevation calculations, radial line triangulations, rectification means, principles of stereoscopic plotting instruments and the multiplex projector are some of the other topics discussed in the following chapters.

As appendices, we have accounts of the standard mapping procedure in vogue among the Royal Canadian Engineers, and of multiplex and stereoplanigraph equipment.

Photogrammetric methods have their limitations too, and these are presented on page 90. To overcome the loss of definition resulting from motion of the aircraft, a moving film Camera is suggested as a remedy. In spite of its restricted photogrammetric applications, the Sonne Camera is said to produce sharp photography at a very large scale from fast moving aircraft. In this camera the sensitive film is made to move at a controllable speed upon a fixed focal plane slit. For perfect synchronisation, the speed of the film is to the speed of the aircraft as the ratio of the focal length to the altitude, when there will be no motion of the image relative to the film during the exposure.

Dr. Trorey's book is most valuable for the man who wants to make maps from air photographs. A fastidious observer might remark that formulæ quoted are not always proved. But those interested in proofs can obtain them elsewhere. The practical application of the formulæ is rendered very clear by the large number of worked examples. As the author himself puts it succinctly, although the metamorphosis from the plain sheet of paper to the finished three colour sheet may seem complex and mysterious, the entire process may be broken up into a number of unit operations each of which is simple and easy to understand. Than this there could be no better description of the book. Photogrammetry and stereoscopy can be difficult to comprehend. But this book gives a delightfully clear treatment of the entire problem by analysing it into a number of small comprehensive processes, each of which is explained fully.

P. SRINIVASA ROW.

Nomenclator Zoologicus, Vol. V, 1936-45. Edited by S. A. Neave. (Published by the Zoological Society of London, Regent's Park, London, N. W. 8), 1950. Pp. 308. Price 3½ guineas.

Nomenclator Zoologicus is an indispensable book of reference for all taxonomists in Zoology. It deals with all the generic names used in zoological literature in any part of the world. The first four volumes of this work were published in 1939 and 1940, and the present volume is the fifth in the series dealing with over 18,000 generic names published between the years 1936 and 1945 both inclusive. The Zoological Society of London has acquired the copyright of the work and, with the help of a special fund known as the Neave-Lloyd Nomenclator Zoologicus Fund, hopes to continue to issue one volume of this series every ten years covering the new generic names used in zoological literature, provided of course that the publication will receive the encouragement and financial support of zoologists.

Considering the difficulties met with in the collection of the scattered zoological literature published during World War II, the work has been carefully planned and executed, and is free from printers' errors. The main work is followed at the end by the Addenda and Corrigenda to the first four volumes already published, the shortness of which is a measure of editorial care and alertness.

The significance of a thick or thin dagger before some class or sub-class names, as for instance against Mammalia (*Ictidailurus* on p. 122), is not explained. The omission of the group, class or phylum in the case of old names of genera where the cross reference is on a different page places the reader at a slight disadvantage.

The volume is well printed and bound, but the price appears to be very high and beyond the means of all except Institutions and Institutional Zoologists.

Nevertheless, systematic zoologists all over the world owe a deep debt of gratitude to the Zoological Society of London for the promise held to bring out a regular series of publications of this type every ten years.

H. S. R.

SCIENCE NOTES AND NEWS

Fossil Fish and Crabs in the Fuller's earth bed at Kapurdi, Jodhpur, Rajasthan.

Mr. S. K. Barooah, Director, Department of Geology and Mining, Government of Madhya Pradesh, Nagpur, writes: —

The occurrence of fossil mollusca and microforaminifera in the Fuller's earth bed at Kapurdi (25° 54′ 30″ : 71° 22′ 30″) had been reported in a previous communication.[1] These fossils had enabled the beds to be determined as belonging to the Laki series.

Since then some fish remains have been collected and one seemingly well preserved in parts was sent to Dr. E. I. White of the British Museum (Natural History), London, for determination along with a few crab remains.

Professor White writes to say that the fish is a clupeoid but not further determinable and might be any age in the Tertiary. None of the specimens collected so far measures more than three inches in length.

Of the crab, it is said that they are not well enough preserved for close determination unless perhaps by empirical matching with known material.

On reference to Dr. Gordon, she considered that these crabs from the Kapurdi Fuller's earth bed, if they are fresh-water forms, probably belong to the Potamonidæ (transitional forms between tribes Catometopa and Cyclometopa), but that if they are brackish-water or marine forms they belong to some family of the Catometopa, perhaps Ocypodidæ or Grapsidæ. The crabs occur both singly and in clusters of two or more individuals.

My grateful thanks are due to Dr. E. I. White and to Dr. Gordon of the British Museum for determination of the above fossils.

1. *Curr. Sci.*, **15**, 11, 317.

Utilisation of the deposits of sodium sulphate at Didwana

Miss Lily B. Desai and Mr. S. M. Mehta of the Royal Institute of Science, Bombay, write:

In June 1944, M. S. Patel[1] suggested to the Technical Mission from the U.K. appointed by the Government of India to advise them on the question of the production of artificial fertilisers (ammonium sulphate) in India, that if Didwana sodium sulphate[2,3,4] could be made available in sufficient quantity at a reasonable price for at least 25 years it could be utilised for the production of ammonium sulphate and soda-ash at the proposed fertiliser plant by taking advantage of the following reaction:—

(i) $2NH_4OH + 2CO_2 + Na_2SO_4 = 2NaHCO_3 + (NH_4)_2SC_4$.

(ii) $2NaHCO_3 = Na_2CO_3 + CO_2 + H_2O$.

Since there are no data in the literature on the study of the above reaction under Indian conditions, we have performed a series of experiments with sodium sulphate (kindly procured for us by Dr. Patel) and ammonium carbonate under varying conditions of temperature, molal ratio and dilution. It is found that the reaction proceeds smoothly in solution with conversion of as much as 50% of sodium sulphate into sodium bicarbonate, the excess of the latter coming down as fine amorphous precipitate. The mother liquor left over consists primarily of ammonium sulphate and sodium bicarbonate along with the unconverted sodium sulphate and ammonium carbonate. By using the mother liquor as solvent in subsequent reactions as much as 65% of sodium sulphate is converted into sodium bicarbonate in a single reaction. The reaction gives without any recourse to refrigeration a resonable yield of almost pure sodium bicarbonate which could easily be converted into soda-ash; ammonium sulphate can be recovered without much difficulty from the mother liquor at a certain stage in the cycle of reactions.

Details of the work will be published in due course.

To Dr. M. S. Patel the authors are grateful for his kind suggestion. They also desire to thank Dr. B. N. Desai of the India Meteorological Department for his interest in the work.

1. Patel, M. S., Private Communication. 2. Dunnicliff, H. B., *Curr. Sci.*, **1943**, **12**, 7–12. 3. Spencer, E., *Ibid.*, 176–80. 4. Dunnicliff, H. B., *Ibid.*, 295–98.

International Union of Crystallography

By kind invitation of the Swedish National Committee for Crystallography, the Second General Assembly and International Congress of the Union will be held in Stockholm from 27th June to 3rd July 1951. These dates have been chosen in consultation with the Swedish National Committee and with the National Committees of all the Adhering Bodies. Copies of the First Circular (March 1950) can be

had from the General Secretary of the Union, R. C. Evans, Crystallographic Laboratory, Cambridge, England; or from the Secretary to the Government of India, Department of Scientific Research, North Block, Central Secretariat, New Delhi.

Electrochemical Society Inc.—India Section

The inaugural meeting of the India Section of the Electro-Chemical Society Inc. was held on the 23rd and 24th March at the Indian Institute of Science, Bangalore. Dr. B. K. Ram Prasad, the President-elect, delivered the inaugural address on "Some Aspects of the Development of Electro-chemical industries in India". Dr. K. L. Ramaswamy (Sindhri) and Mr. J. Balachandra (Bangalore) were elected Vice-Presidents and Dr. T. L. Ramachar (Bangalore) as Secretary-Treasurer.

Zoological Society of India

The Annual General Meeting of the Calcutta Branch of the Zoological Society of India was held at 34, Chittaranjan Avenue, Calcutta, on April 28, 1950, under the Chairmanship of Dr. S. L. Hora, Director, Zoological Survey of India. The following office-bearers were elected for the year 1950 :—*Chairman* : Dr. J. J. Bhaduri, D.SC. F.N.I. ; *Secretary* : Mr. B. Biswas, M.SC.

Sir Ian Heilbron

The Lord President of the Council has appointed Professor Sir Ian Heilbron, D. S. O., F. R. S., Emeritus Professor of London University, to be Chairman of the Advisory Council for Scientific and Industrial Research in place of Sir Geoffrey Heyworth who has resigned owing to pressure of other public duties.

Research Degree Award

On the recommendation of the Board of Examiners consisting of : Sir Ian Heilbron, F.R.S., Prof. H. Raistrick, F.R.S., and Sir J. L. Simonsen, F.R.S., the thesis entitled "Studies on the Chemical Components of Certain Indian Plant Products," by Sri. S. Sankara Subramanian, M.SC., has been declared qualified for the D.Sc. Degree of the Andhra University.

University of Madras

Applications are invited for the following appointments in the University of Madras:—

1. *Chemistry Departments*: One Professor/One Reader as head of each department for (1) Organic Chemistry and (2) Physical Chemistry. 2. *Botany Department*: Reader/Senior Lecturer according to qualifications. 3. *Zoology Department*: Reader/Senior Lecturer according to qualifications. 4. *Mathematics Departments*: One Senior Lecturer. 5. *Department of Psychology*: One Senior Lecturer. 6. *Department of Geography*: Reader/Senior Lecturer according to qualifications.

The scales of salaries to various appointments are:—*Professor*: Rs. 750-50-1,000; *Reader*: Rs. 400-25-600; *Senior Lecturer*: Rs. 200-15-350-20-450-25-500, with dearness allowance admissible to each scale of pay. Fuller particulars can be had from the Registrar, University of Madras.

The last date for receipt of applications (8 copies) is 30th June 1950.

ACHARYA PRAFULLA CHANDRA MEMORIAL FUND

THE Indian Chemical Society have opened a Memorial Fund in the name of its Founder-President, the late Acharya Prafulla Chandra Ray, to perpetuate the memory of his services to India. A target of Rs. 2,00,000 has been provisionally fixed, from the interest of which the Society proposes (i) to arrange for an annual Memorial Lecture by a distinguished scientist on suitable remuneration and the award of a Souvenir Medal, (ii) to grant scholarships to meritorious post-graduate students of chemistry all over India and (iii) to award the annual P. C. Ray Memorial Prize to the best Indian Research worker in chemistry. This appeal which is supported by distinguished scientists like Sir. J. C. Ghosh, and statesmen like Drs. S. P. Mukherjee and B. C. Roy, will, it is hoped, receive the generous response of all scientists, industrial magnates and the general public.

Contributions may kindly be sent to the Hon. Secretary, Indian Chemical Society, 92 Upper Circular Road, Calcutta.

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